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Caribbean Forester

El Caribbean Forester es una revista semestral gratuita publicada en Puerto Rico desde el año 1938 por el Instituto de Dasonomía Tropical del Servicio Forestal del Departamento de Agricultura de los Estados Unidos. Esta publicación está dedicada a promover la mejor ordenación y utilización de los recursos forestales del trópico con especial énfasis a la región del Caribe.

Provee información a los que laboran en la dasonomía y ciencias afines sobre los problemas específicos que confrontan, las políticas forestales vigentes y el progreso del trabajo que se lleva a cabo para mejorar la ordenación y utilización de los recursos forestales tropicales. También sirve como medio informativo sobre los resultados y el progreso de los programas experimentales, en ordenación forestal tropical y utilización, que se llevan a cabo en el Instituto de Dasonomía Tropical en Puerto Rico. También le brinda una oportunidad a otras personas interesadas en la dasonomía tropical para presentar el resultado de sus trabajos.

Se solicitan aportaciones de otras fuentes en el campo de la dasonomía tropical siempre que no estén considerándose para publicación en otras revistas. El manuscrito generalmente no debe exceder 20 páginas escritas a máquina a doble espacio, aunque ocasionalmente podría aceptarse un artículo más largo cuando tuviera un interés especial.

Los artículos deben someterse en la lengua vernácula del autor, deben incluir su título o posición que ocupa y un resumen corto. Deben estar escritos a máquina a doble espacio, solamente en un lado de la página, en papel blanco primera, tamaño 8½ por 11 pulgadas.

Las tablas deben numerarse consecutivamente, cada una en una hoja separada con su título. Las notas al pie usadas en las tablas deben escribirse a máquina como parte de la tabla y designarse por medio de números.

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Los manuscritos deben enviarse al Director del Instituto de Dasonomía Tropical, Río Piedras, Puerto Rico.

Las opiniones expresadas en esta revista no coinciden necesariamente con las del Servicio Forestal. Los artículos publicados en el Caribbean Forester pueden reproducirse siempre que se haga referencia a la fuente original.

The Caribbean Forester is a free semi-annual technical journal published since 1938 in Puerto Rico by the Institute of Tropical Forestry, Forest Service, U. S. Department of Agriculture. This publication is devoted to the development of improved management and utilization of tropical forest resources, with special interest in the Caribbean region.

Through the pages of the journal tropical foresters and workers in allied scientific fields are informed of specific problems of tropical forestry, policies in effect in various countries, and progress of work being carried out for the improvement of the management and utilization of forest resources. It furnishes a means of distribution of information on the progress and results of the experimental programs of the Institute of Tropical Forestry in Puerto Rico. In addition, it affords an opportunity for other workers in the field of tropical forestry to make available the results of their work.

Contributions for the journal are solicited. However, material submitted should not be under consideration for publication elsewhere. Manuscripts should not ordinarily exceed 20

(Continúa en la portada #3)

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Annual Report For 1962
Institute of Tropical Forestry

GENERAL

Puerto Rico and the U. S. Virgin Islands are faced with three major forest problems: (1) most of the forest land, better suited to forest than to other crops, is devoid of timber, (2) existing forests are low in productivity, and (3) forest products, both local and imported, are incompletely utilized. Deficient forests are a problem on about one-fourth of the land surface of the islands. They limit soil and water conservation and outdoor recreational opportunities. Because of them more than $60,000,000 per year in forest products which might be produced locally are currently imported, including an employment value of not less than $20,000,000 annually. The development of forestry techniques for the solution of these problems is the primary goal of the program of the Institute of Tropical Forestry.

The prospects for meeting these forest problems are improving. On large areas of forest land repeated low yields of other crops have led to a reduction in the intensity of cropping and therefore in direct competition between these other crops and forests. Current public planning is directed more than ever toward the full use of all lands, which for these means the production of forest crops. The local demand for nearly all types of forest products is rising, not only in the absolute, but also per capita. Offshore payments for products which could be produced locally are a growing source of concern. Local incentives for conservation and for industrial development, for which forestry and forest products industries are eligible, are becoming more attractive. Rapidly rising demands for outdoor recreation and continuing unemployment are problems both of which can be solved in part by more forestry. The recent success in establishment of plantations of pine in Puerto Rico makes available a new rapid-growing forest crop adapted to lands too poor for most farm crops and for which a market at early age is assured, thus overcoming important past deterrents to the practice of forestry on private lands.

The program of the Institute during 1962 consisted of five broad lines of work: (1) the search for better techniques for making forest lands productive — *forest management research;* (2) the search for techniques for more effective utilization of forest products, both local and imported — *forest products utilization research;* (3) the application of research results in multiple-use public forestry under tropical conditions — *applied forestry;* (4) assistance to forest landowners and by processors of forest products in the use of better techniques — *technical forestry assistance;* and (5) the use of local forest conditions and forestry experience as a training ground in tropical forestry — *forestry training.*

Forest management research made up about 35% of the program of the Institute in 1962. Continuation of long-range investigations already under way constituted the central core of this activity. Included are the testing of the adaptability of selected species of tropical trees to local sites, the development or improvement of techniques for the production of planting stock, and appraisal of trees already established by measurements of their growth. This year's work was marked by the undertaking of a new study of the climate of the Luquillo Mountain region as it influences forest growth there, and by completion of the shift to electronic techniques wherever advantageous

for summary and analysis of experimental data.

Forest products utilization research accounted for about 15% of the Institute program in 1962. Past investigations of the service life of preservative-treated fence posts of all important local species were continued. Tests of the use of solar heat for drying lumber, begun a year ago, were expanded. New work during the year included exploratory studies of the machinability (suitability for cabinet work) of the wood from locally-grown mahogany trees as a basis for the selection of superior individuals for future production.

Applied forestry, carried out largely within the 28,000-acre Luquillo Experimental Forest, made up about 30% of the program of the Institute in 1962. Protection and administration of the forest continued. The first silvicultural treatment of the 7,000-acre timber production area within the forest, started in 1955, was completed, and all plantations were liberated. The field work of an inventory of this area was completed preparatory to revision of the management plan. A direct information service to recreationists visiting the forest was inaugurated.

Technical forestry assistance to landowners and processors of forest products constituted about 15% of the program of the Institute in 1962. This activity included demonstrations, advice, and cost-sharing on nursery practice, reforestation, forest improvement, timber processing, and wood preservation. The work was expanded geographically in Puerto Rico and in scope in the Virgin Islands.

Forestry training made up about 5% of the program of the Institute during 1962. The annual three-month tropical forestry short course for foreign students was held and in addition the Institute was host to a new course which promises to become recurrent, a 12-week, graduate-level summer session on tropical forestry directed by New York State College of Forestry at Syracuse University.

Current developments and trends suggest that shifts in program emphasis may be anticipated in the future. In forest management research the development of management techniques for producing crops of species already found promising will predominate over the search for new adapted species. These studies will be concerned with the development of superior varieties, site relationships, spacing, and growth rates. Forest products utilization research will continue toward improved techniques for seasoning and service life of wood, and will place increased emphasis upon utilization of wood from local plantations. In applied forestry there can be predicted an overall intensification of multiple use in the Luquillo Forest, involving expansion of recreation facilities, including new areas, and in the timber production area of this forest, more drastic improvement cuttings or replacement of existing stands by planting. Technical forestry assistance will concentrate more on commercial forests and less on subsistence woodlots. Post treatment facilities will be installed and tested on a commercial scale. Forestry training can be expected to expand and to rise in level of presentation.

FACILITIES

The two-story headquarters building of the Institute continues to serve adequately current needs. The headquarters library continues to grow through a systematic procedure for obtaining desired references cited by several sources, particularly the Centralized Title Service of the Commonwealth Forestry Bureau. Reindexing of all unbound material in accordance with the Oxford system and rearranging on the shelves by place of origin was completed. The library contains over 7,000 titles and receives nearly 60 periodicals pertinent to tropical forestry.

The headquarters experimental nursery has become inadequate for the production of planting stock for all adaptability studies and will become moreso for anticipated tests

of teak, mahogany, and pine provenance. Currently the overflow is being produced at the Catalina nursery of the Commonwealth Division of Forests. A head-house, providing for propagation under shade, packing, and storage, is being constructed in the experimental nursery, as are two hydroponics beds for controlled testing of the influence of water, nutrients, and rooting media upon planting stock quality.

The experimental solar drier, constructed and first tested in 1961, was expanded to a capacity of 3,000 board feet, and improved temperature and humidity recorders were installed in response to unusual interest on the part of local processors.

Numerous experimental areas are administered by the Institute. The chief one, the Luquillo Experimental Forest, covering 27,889 acres in eastern Puerto Rico, was increased 1,568 acres during the year by a land exchange. A second land exchange promises to increase this area another 109 acres. Steps were begun to acquire Estate Thomas, a tract of 147 acres, for research on the island of St. Croix. This tract is covered largely with a young stand of small-leaf mahogany.

The nature of the work of the Institute has required access to a greater variety of sites than those represented within the areas administered directly. Studies are in progress on various areas within the 60,000 acres of Commonwealth Forests in Puerto Rico, and on more than 200 acres of other lands, both public and private, in both Puerto Rico and the Virgin Islands.

PERSONNEL

The working force of the Institute during 1962 was 52 employees, of which 24 were permanent and full-time. A new position of importance was that of a Visitors Information Service Officer, appointed during the year and stationed in the Luquillo Experimental Forest. All permanent employees took advantage of specialized training opportunities during the year, nine left their posts of duty to attend such activities. In the 98,564 man-hours of work performed during the year, there were no disabling injuries. Two vehicle accidents occurred in 112,500 miles of driving.

EXTERNAL RELATIONS

The progress of the Institute depends in large measure on the effectiveness of relationships leading to cooperation by others directly in its work or in the practice of better forestry. Part of this cooperation is in the form of land made available for the use of the Institute. The headquarters building, laboratories, and nursery in Río Piedras are on lands of the University of Puerto Rico. Office and nursery space in the Virgin Islands is provided by the Virgin Islands Agricultural Program. Experiments in and demonstrations of planting and fence post service life are in progress on the lands of more than 30 cooperators, chief of which are the Puerto Rico Division of Forests and the Virgin Islands Corporation. The Agricultural Extension Service of the University of Puerto Rico and the Soil Conservation Service of the U. S. Department of Agriculture have assisted in the location of landowners for such cooperation.

Forest research is assisted directly or actually conducted by cooperators, a development which grew in importance during 1962. Technical counsel on experimental design and techniques used in related work has come from the Agricultural Experiment Station of the University of Puerto Rico, the Soil and Water Conservation Branch of the Agricultural Research Service, and the Forest Products Laboratory of the Forest Service at Madison, Wisconsin. Libraries of the Institute and the Experiment Station have been shared. The Experiment Station has also at Institute expense, undertaken leaf analyses as a part of an Institute study on the effect of the use of fertilizers on forest plantations. Forest soil analyses were undertaken by the Soil and Water Conservation Branch of ARS.

The Puerto Rico Division of Forests, in coordination with the Institute, established tests of tree adaptability and studies with its pilot plant for the pressure treatment of fence posts with preservatives. The State College of Forestry at Syracuse, New York, as a part of its 1962 summer session in tropical forestry, undertook several five-week forest research projects in cooperation with the Institute. The Quartermaster Research and Engineering Command of the Army provided weather data from within and near the Luquillo Forest and shared in the cost of their analysis. Finally, much of the research progress of the past year has been due to generous provision for and counsel in the use of electronic data processing equipment by the Agricultural Experiment Station of the University of Puerto Rico.

The Institute has shared the resources at its disposal with its many cooperators. Office space in the Río Piedras headquarters building is provided to the Experiment Station. A suitable building in the Luquillo Experimental Forest was made available to the University of Puerto Rico as a station for research on the biology of the forest area. A program of technical forestry assistance and related research was conducted for the Virgin Islands Corporation. A program of the Puerto Rico Division of Forests for forest planting stock production and distribution is financed partly through the Institute, which also provides the land for the principal nursery. The Institute and the Division share the costs of a Cooperative Forest Management program administered by the Division and providing technical forestry assistance to landowners and processors. The Institute provides technical supervision of a roadside tree management program financed by the Virgin Islands government. Land areas within the Luquillo Forest have been made available for specialized studies by the Air Force, the University of Texas, the Atomic Energy Commission, the Waterways Experiment Station at Vicksburg, and numerous individual scientists. More than 150 permits for a variety of continuous uses of areas within the Luquillo Forest are in effect.

Direct technical assistance was provided for the betterment of forestry practices. At the planning level, Institute personnel served on three Technical Action Panels of the Rural Areas Development program of the Department of Agriculture, advising local committees on the potentialities of forestry, including related industrial development. Field demonstrations of preservative treated fence posts were established on private lands and one-day treatment demonstrations were held. In addition, technical assistance was offered to numerous industrial timber processors.

The Director represented the United States in two international conferences: (1) the 8th British Commonwealth Forestry Conference at Nairobi, Kenya, June 25 to July 30, and (2) the 8th Session of the Latin American Forestry Commission at Santiago, Chile, November 8 to 19. At the latter conference a resumé of the programs of Latin-American institutions conducting forestry research was presented by the Institute.

FOREST MANAGEMENT RESEARCH

Research in forest management at the Institute is currently a single major project, designated Tropical Silviculture. Within this project studies are directed toward a wide range of objectives, all of which will contribute to better silviculture. Studies of *dendrology* have as their objective the facilitation of the identification of trees and other forest plants. Studies of *phenology* concern the timing of plant processes such as growth, flowering, and fruiting, as related to seasonal external influences. *Variation and selection* studies involve the search for strains of the accepted tree species which are genetically superior, as a preliminary to more formal forest genetics studies. Investigations of *site improvement* are concerned currently with the effects upon tree growth of artificially increased nutrient supplies. *Nursery*

practice currently is investigated to the degree necessary to assure successful propagation of experimental stock and to eliminate any major cost barriers to large-scale production of stock of species already proven potentially important. Tests of species adaptability concern the search for better tree species for timber production on the more important local sites. Studies of *growth of trees and stands* are directed toward the effects of site and spacing upon the growth of trees and stands of desirable species.

A total of 69 distinct investigations within this project were under way at the beginning of the year. Of these, six studies were completed. Four new studies were begun, leaving 67 on the active list at the end of the year. Although these statistics may suggest little change in the program, there has begun a transition in the emphasis within this project. Now that a few valuable species have been tentatively accepted as adapted to certain of the various major sites of Puerto Rico and the Virgin Islands less emphasis is being placed upon adaptability studies and more is on the techniques for using these species where adapted. Attention has turned to genetic provenance, plantation spacing, and other aspects of establishment and management of these species.

DENDROLOGY

Past work in the field of dendrology has included the establishment of a herbarium of local trees, the preparation of a popular manuscript on 250 of the common trees, the construction of preliminary keys for field identification of trees, and the planting of an arboretum of timber species at Ciénaga Alta in the Luquillo Experimental Forest.

The Ciénaga Alta Arboretum, composed of small plantings, ranging from 8 to 49 trees, of prospective timber species was expanded by the introduction of 13 new species. These are paraná pine *(Araucaria angustifolia)* from Brazil and from Argentina, cunninghamia (*Cunninghamia lanceolata)* from India, redwood (*Sequoia sempervirens*) from the United States, West Indian pine *(Pinus occidentalis)* from Haiti, eucalyptus *(Eucalyptus saligna, E. maculata, E. maidenii, E. robusta,* and *E. paniculata)* from Brazil, Honduras pine *(Pinus caribaea)* from Honduras, Spanish-cedar *(Cedrela odorata)* from Mexico, and yagrumo hembra *(Cecropia* spp.) from local sources. This brings to a total of 45 the number of species in this arboretum.

Unexpected printing delays postponed publication of Arboles Comunes de Puerto Rico e Islas Vírgenes. During the year publication of the English version, Common Trees of Puerto Rico and the Virgin Islands, was approved. There are prospects that both the English and the Spanish editions will be printed in 1963.

PHENOLOGY

Analysis of the first phenological studies in the forests of Puerto Rico are still under way. Three years of coordinated weekly measurements of rainfall and individual tree growth and continuous measurements of temperature and humidity were completed at four distinct sites between 500 and 1,500 feet elevation in the Luquillo Forest. These data, including hourly readings of temperature and humidity, total more than 130 000 measurements and are being processed electronically. Supplemented by more complete data from nine Army weather stations in and near the Luquillo Mountains, an overall analysis of Luquillo Mountain weather, based upon nearly 400,000 hourly observations is in progress. Coordinated readings of rainfall, soil moisture, and tree diameter growth are continuing at one of the original four stations.

VARIATION AND SELECTION

The selection for local sites of timber species from the vast array available in the tropical world has in the past taken precedence over the study of natural variation and bases for selection of superior strains within species. Mass selection of future seed bearers on the broad basis of growth rate and form

has been a secondary benefit of improvement work in existing stands and thinnings in plantations. Variations in the growth rate and form of teak *(Tectona grandis* L.), bigleaf mahogany *(Swietenia macrophylla* King) and Honduras pine *(Pinus caribaea hondurensis)* have been observed and it appears that some of these are hereditary. However, these promising species are represented in this area by only a few provenances, so more introductions are needed before the prospects of genetic improvement can be appreciated.

Preliminary trials in pure plantations of Honduras pine indicated that on the better sites, after only one year, some seedlings make height growth highly significantly greater than that of their neighbors in the plantation. A number of such seedlings at several locations have been identified to determine whether this rapid early growth is continued in later years.

A study of the wood of bigleaf mahogany, described elsewhere in this report, is directed toward the recognition of superior wood quality in standing trees which in other respects are superior.

SITE IMPROVEMENT

The fact that many species of timber trees will thrive in climates or on soils too adverse for the economic production of other crops has led to a concentration of forestry research effort on these poor sites. Timber trees adapted to many of them have been found, but it has also come to light that the species producing the most highly prized timbers respond favorably to and, like other crops for commercial production, may require more favorable conditions. The growing need to put to use all lands in the islands and the extensive area which can be used only for forest suggests that timber crops might be offered better growing environment more practically by improvement of these poorer sites than by moving the trees to better ones.

Tests of the response of plantation teak to fertilizer application on various sites in Puerto Rico and the Virgin Islands, begun two years ago, provide the first evidence of what might be expected from this practice. Nitrogen, phosphorus, and potassium were applied semiannually in levels up to 800, 400, and 800 pounds per acre, respectively, and with calcium and magnesium present in abundance. Two-year tree diameter growth was highly significantly correlated with total NPK applied, with original tree diameter at breast height, and with location, but was not significantly correlated with the amount applied of any one of these three elements.

Analyses of leaves one year after treatment began, made by the Agricultural Experiment Station, showed that the amount of nitrogen and manganese present was highly significantly correlated with the amount of fertilizer applied, but phosphorus, potassium, iron, and boron were not. A secondary preliminary test made concurrently with these leaf analyses showed that differences in the nitrogen, phosphorus, and potassium contents of the leaves from the terminal shoot, as compared with those from the lower crown were not statistically significant and in fact were negligible. Confirmation of this finding by further tests could lead to important savings in the costs of this experimental technique.

Four related short-term studies, conducted in cooperation with Syracuse University, explored techniques for the investigation of the use of liquid fertilizers, foliar analysis, and soil conditions as measured by lysimeters.

NURSERY PRACTICE

The advantages of using potted planting stock of some timber species, in both post planting survival and growth have justified efforts to improve the techniques for producing such stock, even though the search continues for effective methods of employing less expensive planting material. The development of potting media which are superior in terms of weight and of seedling growth has

continued. Additional tests with fertilized sawdust as a potting medium have given satisfactory development of pine and hardwoods tested. The major difficulty encountered has been providing adequate moisture to the seedlings, because sawdust in polyethylene bags sheds moisture when applied from overhead. This difficulty has been essentially overcome by mixing two parts sawdust with one part vermiculite. Use of shredded coconut fiber in mixture with sawdust or vermiculite has shown no advantages in the nursery. It is somewhat more difficult to insert seedlings during transplanting, but it does hold together slightly better at the time of outplanting.

Daily saturation of the rooting medium with a nutrient solution has yielded faster growth of several hardwoods, but none of the combinations of elements tried as yet has improved the growth of pine.

SPECIES ADAPTABILITY

Studies of the adaptability of planted trees have continued, with current work chiefly on the following major sites: (1) deep sandy loam soils of eastern and central Puerto Rico, (2) deep clay soils of eastern and central Puerto Rico, (3) shallow clay loam soils of eastern Puerto Rico, (4) shallow clay soils of the northern limestone region of Puerto Rico, and (5) shallow clay loam soils of the mountains of St. Croix. Tables 1 to 3 present recent results with some of the species under test on the first two sites listed. Precipitation on the sandy loam site ranges from 50 to 110 inches annually; for the clay from 40 to 150 inches.

Table 1. *Tree heights 12 to 15 months after planting.*

SPECIES	PLOT MEANS-TREE HEIGHT			
	SANDY LOAM SOIL		CLAY SOIL	
	Maximum	Average	Maximum	Average
	Feet	Feet	Feet	Feet
Anthocephalus cadamba	3.1	1.4	1.6	1.4
Araucaria angustifolia	0 9	0 8		
Cordia alliodora	1.2	0.8	1.3	0 8
Cybistax donnell-smithii	2.0	0.7	1.0	0.7
Hibiscus elatus	2.2	2.0	2.1	1.7
Khaya senegalensis	0.9	0.9	1.5	1.2
Maesopsis eminii	2.0	1.5		
Pinus caribaea	2.9	2.0	1.8	1.3
P. douglasiana	1.7	0.6	2.0	1.0
P. elliottii elliottii	1.5	0.9	1.2	1 1
P. michoacana	1.0	0.5	0.0	0 0
P. montezuma	0.0	0.0	1.0	1 0
P. oocarpa	1.9	1.0	1.0	0 6
P. pseudostrobus	2 3	1.3	1.0	0.5
P. taeda	1.0	0.6	1.0	0.5
Swietenia humilis			1.6	1 2
S. mahagoni			2 3	1 6
Taxodium mucronatum			1.9	1.7

Table 2. *Tree heights 24 to 27 months after outplanting.*

SPECIES	PLOT MEANS-TREE HEIGHT			
	SANDY LOAM SOIL		CLAY SOIL	
	Maximum	Average	Maximum	Average
	Feet	Feet	Feet	Feet
Anthocephalus cadamba	4.7	4.7		
Carapa guianensis			5.0	5.0
Casuarina equisetifolia	13.2	13.2		
Cordia alliodora	7.0	7.0		
Cybistax donnell-smithii	3.0	3.0	5.7	2.7
Eucalyptus x bangalore	4.4	4.4	10.0	6.3
E. patentinervis	8.2	8.2		
Hibiscus elatus	7.8	7.0	9.6	9.6
Pinus caribaea	12.7	9.7	6.3	6.3
P. elliottii elliottii			2.6	2.6
P. massoniana	6.0	3.6		
P. occidentalis	6.6	3.8		
Pterocarpus indicus			11.8	11.8
Swietenia humilis			2.7	2.7
S. macrophylla			5.3	4.2
S. mahagoni			6.3	5.8
Tectona grandis	2.0	2.0	7.4	7.4

Table 3. *Tree heights 32 to 40 months after outplanting.*

SPECIES	PLOT MEANS-TREE HEIGHT			
	SANDY LOAM SOIL		CLAY SOIL	
	Maximum	Average	Maximum	Average
	Feet	Feet	Feet	Feet
Anthocephalus cadamba			21.3	20.2
Casuarina equisetifolia			13.3	11.0
Cecropia peltata	6.4	6.4		
Eucalyptus x bangalore	16.4	16.4		
E. patentinervis	11.7	8.1	17.6	15.4
Hibiscus elatus	6.0	4.3	17.1	16.8
Khaya nyasica	2.2	2.2	9.3	8.1
Pinus caribaea	13.2	9.6	10.1	9.2
			6.8	6.7
P. occidentalis	1.6	1.6		
P. taeda			11.3	7.2
Schizolobium parahybum, Brazil			17.3	12.2
S. parahybum, Guatemala			15.3	12.1
Spathodea campanulata	6.2	5.0		
Swietenia macrophylla			8.2	7.1
S. mahagoni			7.9	6.1
Tectona grandis	1.1	1.1	10.5	10.2

Introductions of new species and seed sources during the year totaled 11. Important new sources of seed were East and West Africa and Central America.

A short-term study of site evaluation undertaken in cooperation with Syracuse University provided new information as to variations in stand structure due to environmental factors correlated with altitude in the Luquillo Forest.

GROWTH OF TREES AND STANDS

Past studies of tree spacing and thinning in plantations, carried out on a small scale with several species on a variety of sites, have produced only approximate guides to proper spacing. The more intensive plantation management anticipated for the future will require a stronger experimental basis. To this end 48 yield tables were analyzed (Table 4) to determine those measurable stand characteristics with which tree spacing is related. For the 35 species and species-groups in 7 countries, average spacing between trees was significantly correlated with mean tree diameter at breast height or basal area (which is simply a function of diameter) in 85 percent of the tables; spacing was significantly correlated with total height, and with site quality in 55 per cent of the tables. Finally, 42 per cent of the tables indicated that spacing is correlated with age.

Spacing trials of Honduras pine were established at three locations. Triangular arrangement was used at spacing of 5, 7, 10, and 14 feet between adjacent trees. Diameter growth measurements will be taken annually for analysis.

A composite volume table for tabonuco type forest of the Luquillo Mountains, formerly derived from two formulas was recomputed by a single formula. Master card decks were prepared for this table to permit automatic compilation of volumes from the forest inventory of this area made during the year.

Records of the growth and development of forest plantations growing in tropical Africa under conditions comparable to Puerto Rico and the Virgin Islands were collected. An evaluation of the effects of a number of site factors upon the growth of bigleaf mahogany in plantations within Puerto Rico was made in cooperation with State College of Forestry at Syracuse University.

Table 4. *Yield table analyses of factors to which spacing is related.*

SPECIES	Country	Mean dbh	Mean basal area	Mean total height	SITE: Good and average vs. poor	SITE: Good vs. average	Age
Abies and *Picea*	USA		HS[1]/	---	---	---	---
			S[1]/	---	---	---	
A. grandis	England			HS			
A. magnifica	USA	HS	HS	HS	---	---	HS
Alnus rubra	USA						
Anthocephalus cadamba	Indonesia	HS	HS	HS	S		
Bottomland hardwoods	USA			---	---	---	S
Dalbergia sissoo	India	HS					
Eucalyptus globulus	Spain	S	HS		HS	---	
Fraxinus americana	USA		HS		---	---	---
Hardwoods, mixed	USA	HS	---		---	---	---
Larix decidua	USA					HS	
Liriodendron tulipifera	USA		HS	---	---	---	

Table 4. Cont.

SPECIES	Country	Mean dbh	Mean basal area	Mean total height	SITE: Good and average vs. poor	SITE: Good vs. average	Age
Northern hardwoods	USA		HS		---	---	---
Nyssa sylvatica biflora	USA	HS		---	---	---	---
Picea excelsa	England	HS					
Pinus banksiana	USA			HS	HS	HS	HS
		HS		HS		S	
P. echinata	USA	HS	S	HS	S		
							HS
P. elliottii elliottii	USA	HS	S	S			
		HS		HS	HS	HS	S
P. palustris	USA	HS		HS		S	HS
		HS	HS	HS	HS		HS
			HS	HS	HS		
P. ponderosa	USA	HS		HS	S		
P. resinosa	USA	HS	S				
P. serotina	USA	HS	HS			S	HS
P. sitchensis and *Tsuga heterophylla*	USA	HS	S				
P. taeda	USA	HS	S			HS	S
		HS			HS	HS	HS
		HS		HS			S
		HS		---	---	---	---
P. taeda and *P. elliottii elliottii*	USA	HS		---	---	---	---
Populus deltoides	USA	S			---	---	---
Pseudotsuga menziesii	USA	HS	HS	---	HS	HS	HS
		HS					
Quercus incana	India	HS	HS	HS	---	---	HS
Q. rubra	USA				---	---	---
Q. spp.	USA	HS	HS	HS			---
		HS	HS	---			
		HS	HS	HS	HS		HS
Sequoia sempervirens	USA	HS	HS	HS	---	---	---
Shorea leprosula	Malaya			HS	---	---	---
S. robusta	India	HS	HS	HS			
		HS		---	---	---	
Tectona grandis	India	HS		HS	HS	HS	HS
	Java	HS	HS	HS		HS	
Percentage significant		71	51	55	39	37	42

1/ S indicates a correlation significant at the 5 percent level of confidence; HS, at the 1 per cent level.
Dashed lines indicate the variable was not tested.
Blanks indicate the variable was tested but the correlation was not significant.

OTHER STUDIES

Three additional studies of a preliminary character in the general field of forest management research were carried out in cooperation with Syracuse University. These concerned the interception of precipitation by tabonuco type forest, dry-matter weight ratios for roots, shoots, and leaves in a tree in the tabonuco type forest, and wet- and dry-weight relationships in the wood of ausubo (*Manilkara bidentata*).

FOREST PRODUCTS UTILIZATION RESEARCH

Research in forest products utilization, like that in forest management, is conducted within a single project with this title. This project includes the determination of the potential market for forest products, the relative utility of different woods for this market, the development of new local uses for available woods and techniques for timber harvesting, wood processing, and prolongation of service life. The current program is concerned primarily with the last two objectives, with studies in progress in *seasoning*, *machining*, and *preservation*. Major emphasis was on the first two of these three fields.

A total of 17 studies within this project were under way at the beginning of the year. Of these 1 was completed. Two new studies were begun, leaving 18 active at the end of the year.

SEASONING OF WOOD

The experimental solar heated lumber drier, a simple structure composed of a double layer of clear plastic film over a wood frame, described in the last report, produced such spectacular results that it was expanded to commercial size. The internal dimensions of the drying chamber are now 20 feet in length; 10 feet in width; and from 9 feet, 9 inches to 13 feet, 4 inches in height, accommodating about 4,000 board feet of stickered ¾-inch boards. Nine 18-inch fans powered by three 1½ hp. motors and running at 1,500 r.p.m. now provide internal air circulation. The drier is designed for use with cabinet woods, both local and imported, prior to furniture manufacture.

A test of the solar drier with 8/4 yellow birch bore out earlier results with mahogany. A full charge was placed in the drier in late November, during the rainy season. Its average moisture content was reduced from 27.5 to 13.7 percent in 16 days. A direct comparison with kiln drying was not made but the calculated kiln drying time was 13½ days. With kiln operation costs estimated to be three times as high per day, solar drying would cost $12.00 less per M. board feet.

A load of 8/4 mahogany stock, placed in the solar drier during the late winter dry season, dried from 60 to 15 percent moisture content in 38 days. A comparable air-seasoned pile averaged 28 percent after the same period.

Further studies with solar drying will concern costs, effect of time of year, and wood defects.

MACHINING PROPERTIES

A few first-grade cabinet-wood tree species have been found adapted to certain forest sites in Puerto Rico and the Virgin Islands. The quality of the locally grown wood of these species is of importance, not only for forest products industries which might in the future be based upon them, but also for the selection of genetically superior seed bearers for planting material and the selection of management practices which assure optimum growth rates and development.

Bigleaf mahogany (*Swietenia macrophylla*) was selected as of first priority for such study. This species provides the basis for the present furniture industry, is destined to become more scarce in the areas from which it is imported, and is very promising silviculturally in Puerto Rico and the Virgin Islands. Studies of the machinability of this species were begun in 1962. Lumber from 32 locally

grown trees and from three foreign sources is being compared as to physical properties and shaping quality. In the local material the relationship between shaping quality, if any, and direction of the grain, position in the tree, age of the tree at the time the wood was formed, growth rate, and specific gravity are all being studied. Further tests are projected for local mahogany from three other provenances and sites.

WOOD PRESERVATION

Current studies of service life of fence posts now concerns both the use of creosote and pentachlorophenol with most of the common species and with three nonpressure treatment techniques: cold soaking, hot and cold bath, and double diffusion. Plans are in preparation for a comparative study of pressure and nonpressure treatment, but no new studies in this field were undertaken in 1962.

Reexaminations of service life tests of fence posts showed the following results:

1. Posts of casuarina *(C. equisetifolia)* treated with carbolineum by the hot-and-cold bath method are all sound after 19 years exposure in the wet forest of the Luquillo Mountains. Comparable untreated posts failed after an average of 2.5 years of service life.
2. Posts of eucalyptus (*E. robusta)* and mesa (*Micropholis chrysophylloides)*, treated similarly, are all sound after 13 years of exposure on the north coast and in the central mountains of Puerto Rico. Untreated posts in this test also failed after an average of 2.5 years.
3. Posts of 57 species cold soaked for 5 days in 10 percent pentachlorophenol in diesel oil are, after 10 years of exposure, 50 percent sound on the north coast and 80 percent sound in the central mountains.

OTHER STUDIES

In cooperation with the State College of Forestry of Syracuse University exploratory studies were made of (1) the relationship between wood specific gravity and position in the tree, with bigleaf mahogany (*Swietenia macrophylla*) and teak (*Tectona grandis)*, (2) fence post preservative treatment by pressure methods, and (3) trends in forest products imports into Puerto Rico.

APPLIED FORESTRY

The Institute continued to administer the Luquillo Experimental Forest and to apply within it the Forest Service policy of multiple use and progressive silviculture directed toward improvement of the timber stands.

The completion of a long-pending land exchange increased the size of the Luquillo Forest from 26,321 to 27,889 acres. A second exchange, undertaken during the year, may add about 108 acres more. All boundaries and monuments were checked in the field preparatory to restoration of those lost. Data were collected for a new base map. Construction of two roads, totaling 4.8 miles, was in progress throughout the year.

The first improvement cutting in the timber in the 6,889-acre pilot management area was completed seven years after it began. This consisted principally of the poisoning of undesirable trees, particularly those of inferior species. A secondary, more intensive treatment of 621 acres of plantations within this area was also completed. This treatment consisted of the selection of crop trees and their liberation to a D+d radius.

Preparations were undertaken for a complete revision of the plan for the management of this forest. Review of the designation of areas to research, timber management, recreation, and other uses is nearly complete. A timber inventory was completed and recompartmentation of the pilot management area is under way. More intensive silvicultural treatments are being tested for the second cycle.

The use of the Luquillo Forest for purposes other than timber production is growing rapidly. There have been issued 156 permits for uses such as resorts, organization

camps, picnic areas, radio communications, rights of way, and residences. The most rapid increase in these uses is for recreation, with 182,581 visitor-days to the forest in 1962, an increase of 10% over 1961. To meet this growing demand preliminary planning was done for four new picnic areas and a permanent technical employee was assigned to the La Mina Recreational Area to provide information to visitors.

The Forest Service has made arrangements for the transfer of the 146-acre Estate Thomas Experimental Forest from the Virgin Islands Corporation, thus providing an area in St. Croix for the testing and demonstration of intensive forestry in the natural stands of small-leaf mahogany (*Swietenia mahagoni*) and the plantations of teak (*Tectona grandis*) there. Eight acres of this forest were subjected to an intensive crop-tree liberation cutting.

TECHNICAL FORESTRY ASSISTANCE

Technical assistance in forestry was a continuing activity of the Institute during 1962. Recipients of such assistance were in two general groups: landowners and processors of forest products.

ASSISTANCE IN PUERTO RICO

Landowners

The Institute shared costs with the Commonwealth government for the production and distribution of forest planting stock and for technical assistance to landowners on reforestation and forest management. Farm foresters of the Commonwealth Division of Forests, working under these cooperative programs, met 1,488 requests for technical forestry assistance from landowners. A total of 1,204,925 trees were produced and distributed to farmers and served to reforest 556 acres. This is an increase of 297 in number of requests, and 39,890 in number of trees distributed.

The Commonwealth government, with about 60,000 acres of forest lands, is itself the largest single recipient of assistance from these cooperative programs. A total of 50 acres were planted on Commonwealth forest lands during the year. Technical assistance to the Division of Forests in the management of its lands was offered by the Institute in the layout of administrative studies, nursery techniques for the production of pine planting stock, recreational area planning, and timber stand improvement.

Plantings of Honduras pine for demonstration purposes were established at eight locations on three major soil types in cooperation with the Institute. These plantations, ranging from one-half to five acres in area, are widely dispersed over the island and located along well traveled roads in readily accessible locations. Established primarily at the expense of the landowner, five of the eight are on private farms. In addition to their demonstration value they are expected to yield growth information for research purposes.

Processors of Forest Products

Continued delays in the establishment of commercial facilities for nonpressure preservative treatment of fence posts, in spite of evidence from past research as to the effectiveness of the treatment and the large demand for fence posts in Puerto Rico, and incentives offered by the Commonwealth government for new industries of this type, led the Institute to acquire the basic equipment required for a minimum commercial treating plant. An interested potential entrepreneur has been located, and installation of the plant, in cooperation with the Puerto Rico Economic Development Administration, is anticipated soon. The Institute will serve as technical advisor and will conduct research with the equipment.

Technical assistance was provided to the Agricultural Extension Service and to the

Soil Conservation Service in field demonstrations of timber harvesting equipment and preservative treatment of posts were held in eight locations. About 170 persons attended. These agencies are also being assisted in the establishment of a network of demonstration fences throughout the island. These fences, with posts treated by the Institute and set at the expense of the landowner, are now installed in eight locations. The service life of these posts is being determined as a research aspect of this project.

The solar drier has continued to interest furniture manufacturers, and three lots of lumber were dried in it to show its utility. Samples of local woods adequate for testing for furniture and novelties were provided upon request from local manufacturers.

ASSISTANCE IN THE VIRGIN ISLANDS

During the first half of the year the technical forestry assistance program in the Virgin Islands was financed nearly entirely by the Virgin Islands Corporation. During the second half the Forest Service undertook direct financing of the technical aspects of the program, continuing cooperative relationships with the Virgin Islands Agricultural Program is research and extension, with the Virgin Islands Corporation for logging, milling, and preservative treatment; with the Soil Conservation Service in land use planning; with the Virgin Islands government in planting stock production and roadside tree management; and with private landowners for forestry practices and studies on their lands.

Landowners

Requests for technical assistance were received from about 150 landowners: 135 in St. Croix, 10 in St. Thomas, and 5 in St. John. Response to these requests involved personal contacts on the land and included advice on reforestation, plantation management, stand improvement, insect and disease control, and harvesting. In addition, planting stock was produced and distributed free of charge, a crew of laborers was trained in all aspects of the work and provided technical supervision on work for landowners.

A total of 14,000 potted trees were produced in the nursery, nearly all mahogany (*Swietenia* spp.), but because of adverse weather and personnel limitations only 700 were distributed for the planting of one acre of forest. The remainder are being held over for planting in 1963. The weeding and release of established plantations, promoted by the program, but at the expense of the landowner, were done on 36 plantations, totaling 181 acres. Training of workers and technical supervision of crews engaged in this work for landowners have formed a part of this program. Many of these plantations are the subject of administrative studies in progress by the Institute. In the six years of this program private landowners have invested more than $10,000 in the establishment of forest plantations.

The Virgin Islands government, owner of extensive areas of forest lands, is a major recipient of technical forestry assistance from the Institute. This has included the training and technical supervision of laborers hired by the government for planting and managing plantations on 22 acres of its lands and also along roadsides where timber production is a possibility.

Processors of Forest Products

The limited volume of standing timber available within the Virgin Islands has not, in the past, supported an organized market or logging and milling industry. The high quality of local woods, particularly mahogany and thibet (*Albizia lebbeck)*, suggests that a small industry producing furniture, novelties, and tourist items, could be profitable. As a step in this direction the Virgin Islands Corporation has done custom logging and milling, placing the lumber from trees which

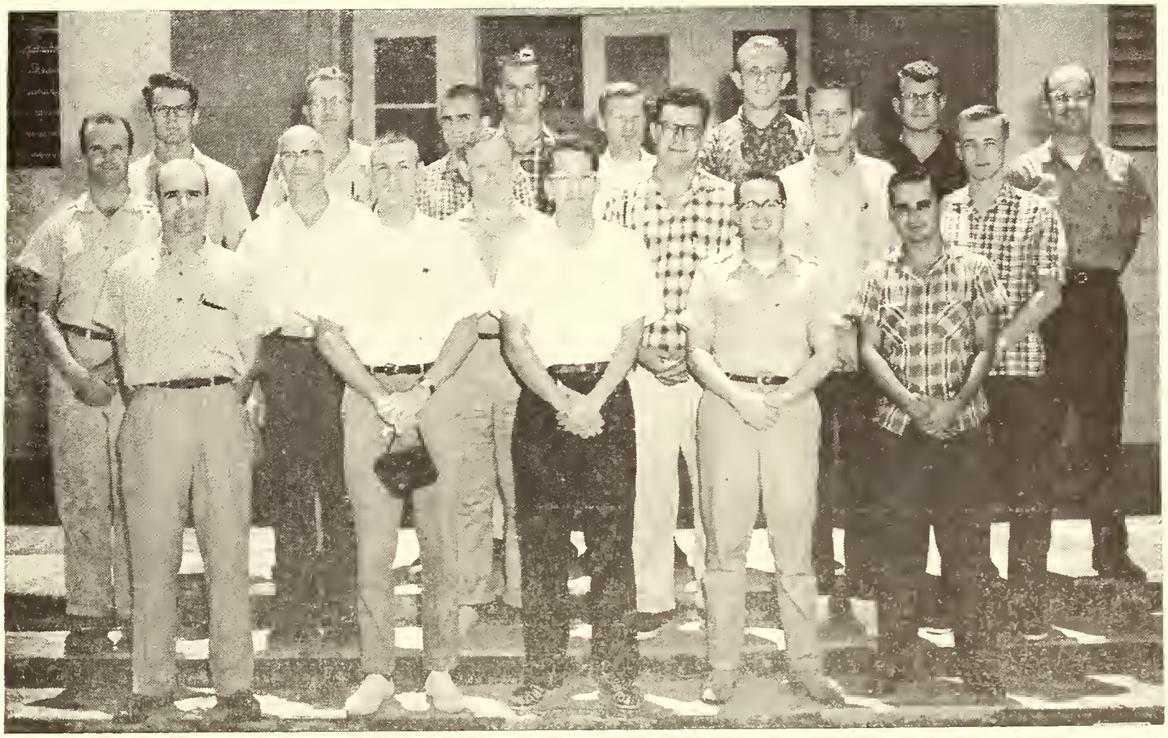

Fig. 1. Participants and instructors, New York State College of Forestry, Summer Session on tropical forestry. Back row from left to right: B. A. Bays, A. G. Clegg, J. Ewel, H. Wisdom, D. Wyckoff, J. Harris, G. Gruenwoldt, C. B. Briscoe. Middle row: H. Barres, J. H. Kraemer, J.E.D. Fox, J. E. Coufal, S. C. Snedaker, H. W. White, Jr. Front row: J. W. Sposta, E. Copus, Jr., J. Hutchinson, R. P. Belanger, V. R. Ortiz.

otherwise would have been unusable at the disposal of local woodworkers.

Under the technical supervision of the program, about 85 trees, mostly mahogany, were logged, and the Sion Farm Sawmill was run intermittently, producing 4,250 board feet of lumber for specialty purposes. Lumber was sold at $400 per thousand board feet green, and $500 seasoned. Slabs, crotches, and miscellaneous chunks sold at from 4 to 5 cents a pound. Most of the material was used for furniture, including such novel uses as coffee tables from slabs and crosscut crotches, lamps, serving boards, and similar uses which make the most of attractive grain. One cabinetmaker put into use a portable chain ripsaw which has facilitated the removal of individual trees where logging equipment is not available. As a result of efforts by the Institute there are now prospects for operation of the Virgin Islands Corporation logging and milling equipment under contract by a cabinetmaker. This would mark an important step forward in Virgin Islands forestry.

The VICORP hot-and-cold bath plant for treating fence posts, operated under the technical supervision of the Institute, was used for the preservation of fence posts removed in stand improvement operations in Estate Thomas experimental forest. In all, 550 posts were treated. Most of these are being used to establish fences on farms in key locations dispersed over the islands. These will establish a basis for estimating expected service life and to attract the attention of private landowners. Two such fences were installed during the year.

Fuelwood cut during silvicultural work at Estate Thomas and from roadside fellings

was made available to the VICORP sugar mill, reducing by about 450 cords the amount required from less discriminate felling elsewhere by contractors.

FORESTRY TRAINING

The role of the Institute as a center for training in tropical forestry became more important in 1962 with the inauguration of a second training course in tropical forestry and a nearly three-fold increase in trainee-days during the year.

The Ninth Tropical Forestry Short Course was held from September 5 to November 28, with 14 participants from British Guiana, the Dominican Republic, Jamaica, Liberia, and the Sierra Leone.

A graduate-level, 12-week summer session in tropical forestry was held at the Institute from June 6 to August 29 by the College of Forestry of State University of New York at Syracuse. Fifteen students, graduates of six forestry colleges, participated. The staff of the Institute provided part of the instruction and guidance on the individual 6-week research projects assigned to the students. Reports of several of these merit publication.

In addition to these formal courses the staff of the Institute provided informal training to 42 other students and visitors from 11 foreign countries.

PUBLICATIONS

Barres, H.

1962. REPORT ON TROPICAL FORESTRY SHORT COURSE. Carib. Forester 23:1:27-32.

Five particpants from four countries were given a 12-week course in tropical forestry.

Briscoe, C. B.

1962. EARLY LIFTING OF PINE SEEDLINGS. ITF Trop. Forest Note 10*, 2 pp.

Seedlings potted four weeks before outplanting grew as well and survived almost as well as seedlings grown in pots.

————

1962. MEDICION DEL CRECIMIENTO DE LOS ARBOLES EN LOS BOSQUES TROPICALES. Carib. Forester 23:1:15-20.

A brief, detailed discussion of tree measurement.

————

1962. TREE DIAMETER GROWTH IN THE DRY LIMESTONE HILLS. ITF Trop. Forest Note 12*. 2 pp.

Swietenia mahagoni plantations grow faster than the best natural forest on this harsh site.

———— and F. B. Lamb

1962. LEAF SIZE IN SWIETENIA Carib. Forester 23:2:112-115.

Measurements of leaflet size strongly indicate that **Swietenia mahagoni** and **S. macrophylla** hybridize freely. The hybrid is easily distinguishable from **S. mahagoni** and partially distinguishable from **S. macrophylla** on the basis of leaflet length only.

———— and R. W. Nobles

1962. HEIGHT GROWTH OF MAHOGANY SEEDLINGS. ITF Trop. Forest Note 13*, 2 pp.

On St. Croix, hybrid mahogany seedlings outgrew both parent species for the first two years on all but the driest site tested.

Englerth, G. H. and E. Goytía Olmedo

1962. THE BOW SAW FOR CUTTING TROPICAL WOODS. ITF Trop. Forest Note 11*, 3 pp.

Describes the use of the bow saw.

Institute of Tropical Forestry.

1962. ANNUAL REPORT FOR 1961. Carib. Forester 23:1:1-14.

A brief description of the activities of the Institute during calendar 1961.

Maldonado, E. D.

1962. SOLAR RADIATION USED TO DRY MAHOGANY LUMBER IN PUERTO RICO. ITF Trop. Forest Note 14*, 5 pp.

Mahogany lumber in a ventilated, plastic-covered shed dried much more rapidly and to a lower moisture content than lumber in covered piles. Seasoning degrade was not increased.

Marrero, J.

1962. PRACTICAS USADAS EN LOS VIVEROS DE PINOS DE PUERTO RICO. Carib. Forester 23:2:87-99.

Describes current nursery techniques, and some of those being tested, at the Institute.

Sposta, J. W.

1962. THE LUQUILLO EXPERIMENTAL FOREST, PUERTO RICO.

A leaflet prepared for distribution to visitors, describing the Luquillo Forest.

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* Copies available upon request.

Brief Notes on Forestry in Southeast Asia

By

F. BRUCE LAMB

SUMMARY

Observations made during a recent survey trip to Southeast Asia are reported. Countries visited were Japan, Taiwan, Philippine Islands, North Borneo, Sarawak, Indonesia, Vietnam, Cambodia, Thailand, and India. The opinion is expressed that if political stability is achieved, forestry will play an important role in the economic development of this area in the years to come.

RESUMEN

Se informan las observaciones hechas durante un viaje de reconocimiento hecho recientemente por el Sureste de Asia. Se visitaron los siguientes países: Japón, Taiwan, Islas Filipinas, Borneo del Norte, Sarawak, Indonesia, Vietnam, Cambodia, Tailan y la India. Según la opinión expresada, si se alcanza la estabilidad política dentro de los próximos años la dasonomía ocupará un lugar importante en el desarrollo económico de esta área.

Southeast Asia constitutes one of the major tropical forest resource areas of the world. This region is also rapidly developing into an important manufacturing area for wood products. Stable progress of forest resource development in this large and varied region depends on full realization of the potential value of the forest resources and the creation of new markets for wood products as well as full exploitation of existing local and world markets.

JAPAN

The Japanese have made an impressive contribution to the utilization of Southsea forest resources in their organization of log transportation to Japanese manufacturing centers, the production of wood products, especially plywood, and the distribution of salable wood merchandise to local and world markets. Their creative enterprise will undoubtedly continue to provide an example of the possible results of well organized effort and financing.

The utilization of local Japanese forest resources plays a relatively small, but nevertheless significant, part in the program.

TAIWAN

A forest resource survey of Taiwan has recently been completed by the Chinese-American Joint Commission on Rural Reconstruction. This study will provide an adequate basis for appraising the part local forest resources can be expected to play in relation to imported logs for the rapidly developing local plywood industry.

An active forest research program is under way at the Taiwan Forest Research Institute located at Taipei. Since the southern part of the island lies in the subtropical and tropical zones, studies which are being carried out there will be of interest to foresters in the American tropics.

Of special note are propagation and plantation management studies with bigleaf mahogany *(Swietenia macrophylla* King). As a result of the observation of a high proportion of mahogany seedlings in nurseries with twisted or deformed roots, a study was undertaken of the relationship between the orientation of the seed at planting and subsequent germination, survival and seedling growth. It was found that the position of the seed in the ground giving best results

was on edge with the rounded edge up. Seeds laid flat, either side up, gave the next best germination, survival, and growth. Placing the seeds in the ground with the broken wing section pointing up or down gave the poorest results. It is common practice in tropical America to plant mahogany seeds with the broken wing section pointing upward. This now appears to be a doubtful procedure.

The reforestation studies with mahogany in Taiwan could benefit from the testing of the various ecotypes of the three species of mahogany (*S. mahagoni*, *S. macrophylla*, and *S. humilis*). Tolerance to a wide range of ecological conditions is represented by these three species and a much wider range of planting sites could be reforested with mahogany if material from all three species were considered.

PHILIPPINE ISLANDS

The Philippine Islands have been the most important source of commercial timber in Southeast Asia for a long time. During recent years a concerted move to establish home-based industries has been made in order to obtain the greatest local economic advantage from the forest resources. The major emphasis has been on plywood production, but hardboard, particle board, and paper are entering the picture.

Two major problems face the Philippine forest industries. The immediate question is one of establishing outlets in local and export markets for locally produced wood products, especially plywood, to compensate for the income formerly obtained from export logs. In this connection there is a big job to be done to establish an exclusive commercial nomenclature for the woods available and a reputation for high quality wood products. Competition is developing with other Southeast Asian sources which supply the market with similar woods. The Philippine position can best be protected by establishing definitive Philippine names for the woods and a reputation for quality in the Philippine wood products.

The other problem is that concerning the long range raw material supply. The forest resources of the Islands are being destroyed at an alarming rate by small farmers working under a system of shifting cultivation called *kaingin* in the Philippines. Both virgin and selectively cut forest areas are being invaded and converted to worthless *cogon* grassland as cultivation is abandoned.

The future of the growing forest industries depends on maintaining the productive capacity of the forests. Permanent industrial forest enterprise has more to contribute to the present and future economy of the Philippine Islands than does the development of a nation of small migrating farmers.

Contact with the Philippine foresters and logging engineers leaves one with the impression of unusual competence and dedication to the national welfare. In addition to the administrative activities of protecting the remaining forest resources and controlling the harvest of the mature and over-mature timber, there are two major problems facing the foresters of the Philippines. One is the protection and management of the second growth and selectively cut forest areas for maximum future production. The other is reforestation of large areas that have been cleared for temporary agriculture, but now, because of loss of soil fertility, produce nothing but useless *cogon* grass.

Considerable information is accumulating in the Philippines in the field of managing selectively cut dipterocarp forests. However, the major source of information on this aspect of tropical forest management under conditions such as exist in the Philippines is Malaya, and no doubt there is much to be gained by taking advantage of the experience accumulated in Malaya.

Reforestation is an activity which is receiving much attention in the Philippines today, and rightly so when one considers the magnitude of the problem. To attain greatest success in this field, advantage should be taken of experience in other tropical areas of the world. Better communication between

foresters of the world is of vital interest as a means of improving forest resource management efficiency.

It was interesting to observe the place bigleaf mahogany is taking in reforestation in the Islands. Ease of propagation, silvicultural characteristics, and wood quality give this species many advantages. Like chinar *(Platanus orientalis* L.) which has become the state tree of Kashmir even though an exotic, bigleaf mahogany (also an exotic) is rapidly becoming the national tree of the Philippines. It is the most abundant shade tree in Manila, and reforestation programs are using it extensively. In openings along logging roads in the forested areas it is commonly found, having become established both by direct seeding and by transplanting. Attention to tree improvement practices in selecting planting stock of mahogany could benefit the reforestation program because of the wide variety of ecotypes available and the wide range of site conditions to be reforested in the Islands.

If full advantage is to be taken of these efforts some attention should also be given to protecting the good name of mahogany. The worldwide reputation of this wood in lumber markets will be much easier to maintain than to reestablish once it is cast in doubt.

NORTH BORNEO AND SARAWAK

It is certainly gratifying to see the conservative approach to forest resource management displayed by these two states, soon to be joined politically with Malaya. The stated policy of the Forest Departments is to set up permanent timber concessions under long-term agreements for timber extraction under the basic principle that security of tenure and long-term planning are essential for successful management.

In North Borneo the lowland commercial Dipterocarp forests cover approximately 9,700 square miles and produce 93% of the timber export, a volume of 490 million board feet in 1960. The concession areas are worked under special licenses which constitute simple working plans. The aim is to achieve sustained yield management. Each concession area is managed as a separate felling series, with annual cut controlled by area allotment. The rotation is established at 80 years, but only one-hundredth of the area of each series is allocated each year in order to make allowance for 20% unworkable forest area.

The individual working circles are exploited under a modification of the "Malayan Uniform System." The actual logging operation is to a certain extent selective. Felling is carried out to a minimum girth limit which varies from 4½ to 6 feet (17 to 23 inches dia.) according to market conditions. The first improvement felling over advanced natural regrowth is carried out by the Forest Department by girdling or poisoning to remove defective trees and undesirable species.

In addition to large semi-permanent timber concessions the Forest Department grants annual licenses to small operators. Indigenous tribes can obtain free use permits for their own domestic purposes.

Reforestation has been undertaken to a limited extent but, logically, in a country with such large timber reserves the major effort is exerted in keeping the forest naturally productive without planting.

The forest resources of Sarawak are somewhat more varied in character than those of North Borneo, which complicates over-all administration. However, basic policies are essentially the same.

It is to be hoped that the present forest policies may continue in effect as the political administration changes over the next few years.

INDONESIA

With the addition of West New Guinea (West Irian) to its territory, Indonesia becomes the mayor forest resource area in Southeast Asia. However, a great deal of information must be obtained before the large forest regions of Kalimantan (Borneo) and New Guinea can be exploited under sound

administrative control. Plans for forest inventories and other studies are being formulated for Kalimantan which will provide a basis for future forest resource development. It is too early to anticipate what developments will take place in West New Guinea.

Important developments have taken place and are continuing in the field of forest plantation establishment and management on the islands of Java and Sumatra. Indonesia has long been a major producer of plantation rubber. This involves plantation management of a forest species (*Hevea brasiliensis* Muell. Arg.), including tree improvement programs and other practices of interest in the field of forestry. Current studies are being made of the possibility of producing pulp and paper from plantations of this species that are on the point of being cut and replanted (age 25 to 35 years).

On the island of Java extensive teak forests *(Tectona grandis* L.f.) are under management. In addition, many other exotic species from all tropical regions have been introduced on a trial basis. Both *Swietenia* from tropical America and *Khaya* from Africa have been planted to a considerable extent. In planting programs using mahogany, preference is now being given to *Khaya* over *Swietenia* because it is apparently more resistant to the mahogany shoot borer (*Hypsipyla robusta)* than *Swietenia* under Indonesian conditions. However, the question of wood quality should also be taken into consideration. Tree improvement studies appear inevitable in the achievement of maximum results in both volume and quality production.

Unfortunately reports of these trials are largely confined to the Dutch and Indonesian languages. However, my respect for the Indonesians as linguists is considerable after a two-week exposure, and I believe they would be glad to present their data in other languages on invitation.

VIETNAM, CAMBODIA, THAILAND

The very brief stops made in these countries provide little basis for comment on the forest situation. Political developments unfortunately are a disrupting factor in some areas.

On the streets of Phnom Penh, Cambodia, one sees a mixture of the mahoganies planted together *(Swietenia* sp. and *Khaya* sp.). This would provide an interesting situation in which to investigate the possibility of the crossing between these two doubtfully distinct genera. Morphological studies of nursery stock would probably give a good indication, which could be followed by cytological studies if crossing appeared to be taking place.

INDIA

Time limitations confined my visit in this fabled land to industrial installations and the Forest Research Institute at Dehra Dun. The physical plant of the Institute and the scope of the work program certainly justify its reputation as one of the world's foremost forest research institutions.

FAO, ROME

Two days were spent at the Forestry and Forest Products Division of FAO in Rome, going over projects and reports from the Southeast Asian area. The contribution of this organization to progress in forest resource development in Southeast Asia has been and undoubtedly will continue to be of great significance.

CONCLUSION

In looking back on this trip the conclusion is inescapable that permanent progress in forest resource utilization and management depends on political and economic stability in the various states of Southeast Asia. If a measure of political stability is achieved, forestry should play an important role in the economic picture in years to come. Activities of the FAO of the United Nations, increased scientific interchange, and various exchanges of technicians can all help to maintain forestry in Southeast Asia in the vital position to which the magnitude of the natural resources entitles it.

Notas Dendrológicas Para el Estado de Campeche, Mexico

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RESUMEN

El presente artículo versa sobre la importancia que tiene la dendrología tropical dentro del campo de la Dasonomía Tropical y la Investigación Forestal Tropical. Además, se incluyen tres listas de los árboles más comunes que se encuentran en el Estado de Campeche, México, ordenados éstos alfabéticamente por nombre común o regional, nombre botánico y familia a que pertenecen. Por último, una lista de nombres comunes de árboles que no se identificaron.

SUMMARY

This article deals with the importance of the dendrology in Tropical Forest Management and Research. Included are three lists of the most common trees found in the State of Campeche, Mexico. These are in alphabetical order by (a) common or regional name, (b) botanical name, and (c) family to which they belong. Finally, there is a list of the common names of trees which were not identified.

La complicada vegetación de México ha sido desde hace muchos años motivo de interés para un gran número de botánicos investigadores, pues en los dos millones de Km^2 con que cuenta este país se encuentra una amplia gama de climas y suelos, debido a sus muy variadas condiciones topográficas y de localización; por lo mismo, gran diversidad de asociaciones ecológicas vegetales están representadas, cada una con sus diferentes etapas de sucesión en constante evolución para llegar al clímax.

Pues bien, cada una de estas asociaciones representa un problema de interés desde el punto de vista botánico. Dentro de esta amplia rama de las ciencias biológicas, todo investigador se formula una pregunta muy común. ¿Cuáles y cuántas especies de interés para mí existirán en esta asociación? Claro está que en sí la pregunta es muy ambigua porque no conocemos el punto de vista que le interesa al investigador, pero si nombramos dos palabras: "Dendrología Tropical", de inmediato nos damos cuenta que las especies de interés para él son las arbóreas que se encuentran dentro de la zona tropical.

Desde el punto de vista dendrológico, el trópico mexicano presenta un extenso campo de acción para desarrollar un programa de investigación básica, cuyos resultados posteriores beneficiarán a programas de investigación forestal aplicada o práctica. Digamos pues, que la dendrología en México, y en todos los países tropicales del mundo que cuentan con áreas boscosas, es el punto básico o de partida para iniciar un programa de investigación forestal. Primero necesitamos encontrar las respuestas a las preguntas: ¿Cuántas especies componen los bosques tropicales? ¿Cuáles son ellas?, para posteriormente hacer inventarios, estudios económico-forestales y estudios silviculturales.

Desafortunadamente, la distribución de especies forestales no es la misma en todos

1/ Los datos que sirven como base de este artículo fueron coleccionados cuando el autor era Jefe del Campo Experimental Forestal Tropical "El Tormento," I.N.I.F., México.

los bosques y así como en América encontramos especies de gran importancia tales como *Swietenia macrophylla* King y *Cedrela mexicana* Roem, en Asia se encuentran otras especies de gran importancia para los bosques de ese continente tales como *Shorea robusta* y *Tectona grandis.* Pero las especies de importancia secundaria, como hasta ahora las hemos llamado por carecer en gran parte de conocimientos sobre la utilización que se puede dar a cada una de ellas, en conjunto representan un papel básico en la composición de los bosques tropicales, supuesto que se encuentran en proporción más elevada no solamente desde el punto de vista cualitativo, sino también cuantitativo.

Después de haber analizado en forma muy somera la importancia que tiene la dendrología en el campo de la dasonomía y sus ramas afines, se sugiere lo siguiente:

La elaboración de un manual ilustrado sobre "Dendrología Tropical" en cada uno de los países que cuentan con bosques tropicales, lo que sería de gran ayuda para ingenieros forestales, técnicos forestales, guardas forestales, y en general para todas aquellas personas que de una manera u otra están en contacto con los bosques tropicales o sus productos.

En ese manual que se sugiere, deben agruparse los datos necesarios para cada una de las especies, principalmente: Nombres comunes o regionales y nombres técnicos, características botánicas, distribución geográfica, especies con que se asocia, condiciones específicas de clima y suelos en los que se encuentra con mayor frecuencia, hábitos de floración y fructificación, capacidad regenerativa, usos regionales, nacionales y mundiales, propiedades físicas y químicas de su madera para las especies más útiles y por último complementar esto con ilustraciones gráficas de material vegetativo en detalle y el aspecto general del árbol, en las especies de mayor utilidad.

A continuación se incluyen tres listas de los árboles más comunes del Estado de Campeche, México, los cuales están ordenados alfabéticamente por nombre común, nombre botánico y familia a que pertenecen; al final, una lista de nombres comunes de árboles que no fueron identificados por motivos ajenos a la voluntad del autor.

En estas listas están incluídas especies arbóreas que son desde arbolitos (de 3 a 5 Mts. de altura), hasta las especies de gran tamaño (50 o más Mts.) como *Ceiba pentandra* (L.) Gaertn. considerada la reina de los bosques tropicales por su impresionante majestuosidad; además, se incluyen algunas especies frutales o de ornato cultivadas, pero que son arbóreas, y algunas de ellas suelen aparecer con frecuencia en forma espontánea como parte componente de los bosques tropicales.

ARBOLES IDENTIFICADOS ORDENADOS ALFABETICAMENTE POR NOMBRE COMUN REGIONAL

Nombre Común	*Nombre Botánico*	*Familia*
Aguacate	*Persea americana* Mill	Lauraceae
Aguacatillo	*Ficus cotinifolia*	Moraceae
Almendro	*Terminalia catappa* L.	Combretaceae
Amapola	*Bombax ellipticum* HBK	Bombacaceae
Anonillo	*Annona reticulata* L.	Anonaceae
Arbol de pan	*Artocarpus altilis* (Park) Fosb.	Moraceae
Balsamo o Nava	*Myroxylon balsamum* (Royle) Harms.	Papilionaceae
Barí	*Calophyllum brasiliense* Camb.	Guttiferae
Bojón	*Cordia gerascanthus* L.	Boraginaceae
Bolchiche	*Coccoloba schiedeana* Lindau	Polygonaceae

Bolchichillo	*Coccoloba cordiophylla*	Polygonaceae
Brasil	*Haematoxylon brasiletto* Karst.	Caesalpiniaceae
Caimitillo	*Chrysophyllum mexicanum* Brondeg.	Sapotaceae
Caimito	*Chrysophyllum cainito* L.	Sapotaceae
Candelero	*Cordia* sp.	Boraginaceae
Canilla de venado	*Gymnopodium antigonoides* (Roh) Blake	Polygonaceae
Canishté	*Lucuma campechiana* HBK	Sapotaceae
Caña fístula	*Cassia fistula* L.	Caesalpiniaceae
Caoba	*Swietenia macrophylla* King	Meliaceae
Capulín	*Muntigia calabura* L.	Elaeocarpaceae
Capulincillo	*Trema micrantha* (L) Blume.	Ulmaceae
Cascarillo grueso	*Croton* sp.	Euphorbiaceae
Cascarillo menudo	*Croton* sp.	Euphorbiaceae
Catalox	*Swartzia cubensis*	Caesalpiniaceae
Cedrillo	*Trichilia cuneata* Radlk.	Meliaceae
Cedro	*Cedrela mexicana* Roem.	Meliaceae
Ceiba o Ceibo	*Ceiba pentandra* (L) Gaertn.	Bombacaceae
Cencerro	*Sweetia panamensis* Benth.	Papilionaceae
Ciruelillo o Pa'asak	*Simarouba glauca* D. C.	Simarubaceae
Cocoite blanco	*Gliricidia sepium* (Jacq.) Steud.	Papilionaceae
Cocoite negro	*Gliricidia guatemalenis* Mich.	Papilionaceae
Cojón de gato	*Thevetia* sp.	Apocinaceae
Cojón de toro	*Stemmadenia* sp.	Apocinaceae
Cola de lagarto	*Zanthoxylum procerum* D. Sm.	Rutaceae
Copal	*Protium copal* (Schl. et Cham.) Engl.	Burseraceae
Copó	*Ficus* sp.	Moraceae
Cornezuelo	*Acacia collinsii* Saff.	Mimosaceae
Cuero de vaca	*Miconia* sp.	Melastomaceae
Chaco o Ramón colorado	*Trophis racemosa* (L.) Urb.	Moraceae
Chacté viga	*Caesalpinia platyloba*	Caesalpiniaceae
Chactekóc o palo de rosa	*Cosmocalys spectabilis* Standl.	Rubiaceae
Chaká	*Bursera simaruba* (L) Sarg.	Burseraceae
Chaká blanco	*Bursera graveolens* (HBK) Tr. et Pl.	Burseraceae
Chakahuanté	*Saurauia* sp.	Saurauiaceae
Chechén blanco	*Cameraria latifolia* L.	Apocynaceae
Chechén negro	*Metopium brownei* (Jacq.) Urban	Anacardiaceae
Chico sapote o sapote	*Achras zapota* L.	Sapotaceae
Chimón	*Ficus* sp.	Moraceae
Chintoke	*Krugiodendron ferreum* (Vahl) Urban	Rhamnaceae
Chukúm	*Pithecolobium* sp.	Mimosaceae
Escobillo	*Eugenia axilaris* (Sw.) Willd.	Mirtaceae
Framboyán	*Delonix regia* (Boj.) Raf.	Caesalpiniaceae
Garrobo	*Acacia* sp.	Mimosaceae
Granadillo	*Platymiscium yucatanum*	Papilionaceae
Grosello cimarrón	*Malpighia* sp.	Malpigiaceae
Guacamayo o Subín	*Acacia dolichostachya*	Mimosaceae
Guácimo	*Luehea speciosa* Willd.	Tiliaceae
Guarumo	*Cecropia peltata* L.	Moraceae

Guaya	*Talisia olivaeformis* (HBK) Radlk.	Sapindaceae
Guayaba	*Psidium guajava* L.	Mirtaceae
Guayabillo	*Psidium sartorianum* (Berg) Nied.	Mirtaceae
Guayacán amarillo	*Tabebuia guayacán* (Seem.) Hemsl.	Bignoniaceae
Guayacán negro	*Tabebuia* sp.	Bignoniaceae
Güiro	*Crecentia cujete* L.	Bignoniaceae
Gusanillo	*Lonchocarpus* sp.	Papilionaceae
Higuillo	*Ficus* sp.	Moraceae
Huesillo	*Eugenia* sp.	Mirtaceae
Hule	*Castilla elastica* Cerv.	Moraceae
Jabín	*Piscidia piscipula* (L.) Sarg.	Papilionaceae
Jaboncillo	*Sapindus saponaria* L.	Sapindaceae
Jobillo	*Astronium graveolens* Jacq.	Anacardiaceae
Jobo	*Spondias mombin* L.	Anacardiaceae
Kantemó	*Acacia angustissima* (Mill) Kuntze	Mimosaceae
Kaxín	*Acacia* sp.	Mimosaceae
Kantsín	*Lonchocarpus rugosus* Benth.	Papilionaceae
Laurelillo	*Nectandra sanguinea*	Lauraceae
Limoncillo	*Randia* sp.	Rubiaceae
Luín	*Ampelocera hottlei* Standl.	Ulmaceae
Maculís o rosa morada	*Tabebuia pentaphylla* (L.) Hemsl.	Bignoniaceae
Machiche	*Lonchocarpus castilloi* Standl.	Papilionaceae
Madre de cacao	*Erythrina glauca* Willd.	Papilionaceae
Majahua palencana	*Belotia mexicana* (D.C.) Sch.	Tiliaceae
Mamey cimarrón	*Calocarpum sapota* (Jacq.) Merr.	Sapotaceae
Mangle colorado	*Rhizophora mangle* L.	Rhizophoraceae
Mamba	*Pseudolmedia oxyphyllaria* D. Sm.	Moraceae
Mango	*Mangifera indica* L.	Anacardiaceae
Marañón	*Anacardium occidentale* L.	Anacardiaceae
Matapalo	*Clusia fava* Jacq.	Clusiaceae
Mora	*Chlorophora tinctoria* (L) Gaud.	Moraceae
Nance o Nanche	*Byrsonima crassifolia* HBK	Malpigiaceae
Nance agrio	*B. bucidaefolia* (L) HBK	Malpigiaceae
Nava o balsamo	*Myroxylon balsamum* (Royle) Harms.	Papilionaceae
Pa'asak o ciruelillo	*Simarouba glauca* Dc.	Simarubaceae
Palo de rosa o chactekoc	*Saurauia* sp.	Saurauiaceae
Papelillo o Tabaquillo	*Alseis yucatanensis*	Rubiaceae
Pelagente	*Ficus* sp.	Moraceae
Pelmáx	*Aspidosperma stegomeris* (Woods) Woods.	Apocynaceae
Pepino de árbol	?	Bignoniaceae
Pich	*Enterolobium cyclocarpum* (Jacq.) Griseb.	Mimosaceae
Pimientillo	*Ocotea veragensis* (Meissn.) Mez.	Lauraceae
Pimiento	*Phoebe* sp.	Lauraceae
Pixóy	*Guasuma ulmifolia*	Esterculiaceae
Pochote	*Cochlospermum vitifolium* (Willd) Spreng.	Cochlospermaceae
Polmoché	*Jatropha curcas* L.	Euphorbiaceae
Popistle blanco	*Psychotria* sp.	Rubiaceae
Popistle negro	*Blepharidium mexicanum* Standl.	Rubiaceae

Pozol agrio	*Sapium macrocarpum* M. Arg.	Euphorbiaceae
Puk'té	*Bucida buceras* L.	Combretaceae
Ramón	*Brosimum alicastrum* Sw.	Moraceae
Ramón colorado o chaco	*Trophis racemosa* (L.) Urb.	Moraceae
Rosa morada o Maculís	*Tabebuia pentaphylla* (L.) Hemsl.	Araliaceae
Salchaká	*Gilibertia arborea* (L.) March.	Bignoniaceae
Sapote o chico sapote	*Achras zapota* L.	Sapotaceae
Sapote Faisán	*Dipholis salicifolia* (L.) A. Dc.	Sapotaceae
Sapotillo	*Sideroxylon* Sp.	Sapotaceae
Sinanché	*Zanthoxylum* sp.	Rutaceae
Siricote	*Cordia dodecandra* DC.	Boraginaceae
Subín o guacamayo	*Acacia dolichostachya*	Mimosaceae
Tabaquillo o papelillo	*Alseis yucatanensis*	Rubiaceae
Tabasché	*Exostema mexicanum* A. Gr.	Rubiaceae
Tamarindo	*Tamarindus indica* L.	Caesalpiniaceae
Tamarindo cimarrón	*Calliandra tonduzii* (Br. et Rose) Standl.	Mimosaceae
Tinto	*Haematoxylon campechianum* L.	Caesalpiniaceae
Tocúy	*Pithecolobium calostachys*	Mimosaceae
Tza'alam	*Lysiloma bahamensis* Benth	Mimosaceae
Unliche	*Tabernaemontana amygdalaefolia* Jacq.	Apocynaceae
Uva de mar	*Coccoloba uvifera* L.	Polygonaceae
Uvero	*Coccoloba* sp.	Polygonaceae
Visiník	*Alvaradoa amorphoides* Liebm.	Simarubaceae
Vix	*Inga* sp.	Mimosaceae
Ya'axnik	*Vitex gaumeri* Greenm.	Verbenaceae
Yaití	?	Euphorbiaceae
Yaya	*Oxandra* sp.	Anonaceae

ARBOLES IDENTIFICADOS, ORDENADOS ALFABETICAMENTE POR NOMBRE BOTANICO

Nombre Botánico	*Familia*	*Nombre Común*
Acacia angustissima (Mill) Kuntze	Mimosaceae	Kantemó
Acacia collinsii Staff.	Mimosaceae	Cornezuelo
Acacia dolichostachya	Mimosaceae	Subín o guacamayo
Acacia sp.	Mimosaceae	Kaxín
Acacia sp.	Mimosaceae	Garrobo
Achras zapota L.	Sapotaceae	Sapote o Chico sapote
Alseis yucatanensis	Rubiaceae	Tabaquillo o papelillo
Alvaradoa amorphoides Liebm.	Simarubaceae	Visiník
Ampelocera hottlei Standl	Ulmaceae	Luín
Anacardium occidentale L.	Anacardiaceae	Marañón
Annona reticulata L.	Anonaceae	Anoníllo
Artocarpus altilis (Park) Fosb.	Moraceae	Arbol del pan
Aspidosperma stegomeris (Woods) Woods.	Apocinaceae	Pelmáx
Astronium graveolens Jacq.	Anacardiaceae	Jobillo
Belotia mexicana (D.C.) Sch.	Tiliaceae	Majahua palencana
Blepharidium mexicanum Standl.	Rubiaceae	Popistle negro

Bombax ellipticum HBK	Bombacaceae	Amapola
Brosimum alicastrum Sw.	Moraceae	Ramón
Bucida buceras L.	Combretaceae	Puk'té
Bursera graveolens (HBK) Tr. et Pl.	Burseraceae	Chaká blanco
Bursera simaruba (L.) Sarg.	Burseraceae	Chaká
Byrsonima bucidaefolia (L) HBK	Malpigiaceae	Nance agrio
Byrsonima crassifolia HBK	Malpigiaceae	Nance o Nanche
Caesalpinia plathyloba	Caesalpiniaceae	Chacté viga
Calocarpum sapota (Jacq.) Merr.	Sapotaceae	Mamey cimarrón
Calophyllum brasiliense Camb.	Guttiferae	Barí
Calliandra tonduzzi (Br. et Rose) Standl	Mimosaceae	Tamarindo cimarrón
Cameraria latifolia L.	Apocinaceae	Chechén blanco
Cassia fistula L.	Caesalpiniaceae	Caña fístula
Castilla elastica Cerv.	Moraceae	Hule
Cecropia peltata L.	Moraceae	Guarumo
Cedrela mexicana Roem.	Meliaceae	Cedro
Ceiba pentandra (L) Gaertn.	Bombacaceae	Ceibo o ceiba
Clusia fava Jacq.	Clusiaceae	Matapalo
Coccoloba cardiophylla	Polygonaceae	Bolchichillo
Coccoloba schiedeana Lindau	Polygonaceae	Bolchiche
Coccoloba sp.	Polygonaceae	Uvero
Coccoloba uvifera L.	Polygonaceae	Uva de mar
Cochlospermum vitifolium (Willd) Spreng.	Cochlospermaceae	Pochote
Cordia dodecandra DC.	Boraginaceae	Siricote
Cordia gerascanthus L.	Boraginaceae	Bojón
Cordia sp.	Boraginaceae	Candelero
Cosmocalys spectabilis Standl.	Rubiaceae	Chactekoc o palo de rosa
Crecentia cujete L.	Bignoniaceae	Güiro
Croton sp.	Euphorbiaceae	Cascarillo grueso
Croton sp.	Euphorbiaceae	Cascarillo menudo
Chlorophora tinctoria (L) Gaud.	Moraceae	Mora
Chrysophyllum cainito L.	Sapotaceae	Caimito
Chrysophyllum mexicanum Brondeg.	Sapotaceae	Caimitillo
Delonix regia (Boj.) Raf.	Caesalpiniaceae	Framboyán
Dipholis salicifolia (L.) A. Dc.	Sapotaceae	Sapote Faisán
Enterolobium cyclocarpum (Jacq.) Griseb.	Mimosaceae	Pich
Erythrina glauca Willd.	Papilionaceae	Madre de cacao
Eugenia axilaris (Sw) Willd.	Mirtaceae	Escobillo
Eugenia sp.	Mirtaceae	Huesillo
Exostema mexicanum A. Gr.	Rubiaceae	Tabasché
Ficus cotinifolia	Moraceae	Aguacatillo
Ficus sp.	Moraceae	Copó
Ficus sp.	Moraceae	Chimón
Ficus sp.	Moraceae	Higuillo
Ficus sp.	Moraceae	Pelagente
Gilibertia arborea (L.) March.	Araliaceae	Salchaká
Gliricidia guatemalensis Mich.	Papilionaceae	Cocoite negro
Gliricidia sepium (Jacq.) Steud.	Papilionaceae	Cocoite blanco

Guasuma ulmifolia	Esterculiaceae	Pixóy
Gymnopodium antigonoides (Roh) Blake	Polygonaceae	Canilla de venado
Haematoxylon brasiletto Karst.	Caesalpiniaceae	Brasíl
Haematoxylon campechanum L.	Caesalpiniaceae	Tinto
Inga sp.	Mimosaceae	Vix
Jatropha curcas L.	Euphorbiaceae	Polmoché
Krugiodendron ferreum (Vahl) Urban	Rhamnaceae	Chintoke
Lonchocarpus castilloi Standl.	Papilionaceae	Machiche
Lonchocarpus rugosus Benth.	Papilionaceae	Kantsín
Lonchocarpus sp.	Papilionaceae	Gusanillo
Lucuma campechiana HBK	Sapotaceae	Canishté
Luehea speciosa Willd.	Tiliaceae	Guácimo
Lysiloma bahamensis Benth	Mimosaceae	Tza'alam
Malpighia sp.	Malpigiaceae	Grosello cimarrón
Mangifera indica L.	Anacardiaceae	Mango
Metopium brownei (Jacq.) Urban	Anacardiaceae	Chechen negro
Miconia sp.	Melastomaceae	Cuero de vaca
Muntigia calabura L.	Elaeocarpaceae	Capulín
Myroxylon balsamum (Royle) Harms.	Papilionaceae	Nava o balsamo
Nectandra sanguinea	Lauraceae	Laurelillo
Ocotea veragensis (Meissn.) Mez	Lauraceae	Pimientillo
Oxandra sp.	Anonaceae	Yaya
Persea americana Mill.	Lauraceae	Aguacate
Phoebe sp.	Lauraceae	Pimiento
Piscidia piscipula (L.) Sarg.	Papilionaceae	Jabín
Pithecolobium calostachys	Mimosaceae	Tocúy
Pithecolobium sp.	Mimosaceae	Chukúm
Platymiscium yucatanum	Papilionaceae	Granadillo
Protium copal (Schl. et Cham.) Engl.	Burseraceae	Copal
Pseudolmedia oxyphyllaria D. Sm.	Moraceae	Mamba
Psidium guajava L.	Mirtaceae	Guayaba
Psidium sartorianum	Mirtaceae	Guayabillo
Psychotria sp.	Rubiaceae	Popistle blanco
Randia sp.	Rubiaceae	Limoncillo
Rhizophora mangle L.	Rhizophoraceae	Mangle colorado
Sapindus saponaria L.	Sapindaceae	Jaboncillo
Sapium macrocarpum M. Arg.	Euphorbiaceae	Pozol agrio
Saurauia sp.	Saurauiaceae	Chakahuanté
Sideroxylon sp.	Sapotaceae	Sapotillo
Simarouba glauca Dc.	Simarubaceae	Pa'asak o ciruelillo
Spondias mombin L.	Anacardiaceae	Jobo
Stemmadenia sp.	Apocynaceae	Cojón de toro
Swartzia cubensis	Caesalpiniaceae	Catalox
Sweetia panamensis Benth	Papilionaceae	Cencerro
Swietenia macrophylla King	Meliaceae	Caoba
Tabebuia guayacán (Seem.) Hemsl.	Bignoniaceae	Guayacán amarillo
Tabebuia pentaphylla (L.) Hemsl.	Bignoniaceae	Masculis o rosa morada
Tabebuia sp.	Bignoniaceae	Guayacán negro

Tabernaemontana amygdalaefolia Jacq.	Apocynaceae	Unliche
Talisia olivaeformis (HBK) Radlk	Sapindaceae	Guaya
Tamarindus indica L.	Caesalpiniaceae	Tamarindo
Terminalia catappa L.	Combretaceae	Almendro
Thevetia sp.	Apicynaceae	Cojón de gato
Trema micrantha (L.) Blume	Ulmaceae	Capulincillo
Trichilia cuneta Radlk	Meliaceae	Cedrillo
Trophis racemosa (L.) Urb.	Moraceae	Ramón colorado o chaco
Vitex gaumeri Greenm	Verbenaceae	Ya'axnik
Zanthoxylum procerum D. Sm.	Rutaceae	Cola de lagarto
Zanthoxylum sp.	Rutaceae	Sinanché

LISTA DE ARBOLES IDENTIFICADOS ORDENADOS ALFABETICAMENTE POR FAMILIAS

	Anacardiaceae	
Anacardium occidentale L.		Marañón
Astronium graveolens Jacq.		Jobillo
Mangifera indica L.		Mango
Metopium brownei (Jacq.) Urban		Chechen negro
Spondias mombin L.		Jobo
	Anonaceae	
Annona reticulata L.		Anonillo
Oxandra sp.		Yaya
	Apocynaceae	
Aspidosperma stegomeris (Woods) Woods.		Pelmáx
Cameraria latifolia L.		Chechén blanco
Stemmadenia sp.		Cojón de toro
Tabernaemontana amygdalaefolia Jacq.		Unliche
Thevetia sp.		Cojón de gato
	Araliaceae	
Gilibertia arborea (L.) March		Salchaká
	Bignoniaceae	
Crecentia cujete L.		Güiro
Tabebuia guayacán (Seem.) Hemsl.		Guayacán amarillo
Tabebuia pentaphylla (L.) Hemsl.		Maculís o rosa morada
Tabebuia sp.		Guayacán negro
?		Pepino de árbol
	Bombacaceae	
Bombax ellipticum HBK.		Amapola
Ceiba pentandra (L.) Gaertn		Ceibo o Ceiba
	Boraginaceae	
Cordia dodecandra DC.		Siricote
Cordia gerascanthus L.		Bojón
Cordia sp.		Candelero

	Burseraceae	
Bursera graveolens (HBK) Tr. et Pl.		Chaká blanco
Bursera simaruba (L.) Sarg.		Chaká
Protium copal (Schl. et Cham.) Engl.		Copal
	Caesalpiniaceae	
Caesalpinia platyloba		Chacté viga
Cassia fistula L.		Caña fístula
Delonix regia (Boj.) Raf.		Framboyán
Haematoxylon brasiletto Karst.		Brasil
Haematoxylon campechianum L.		Tinto
Swartzia cubensis		Catalóx
Tamarindus indica L.		Tamarindo
	Clusiaceae	
Clusia fava Jacq.		Matapalo
	Combretaceae	
Bucida bucera L.		Puk'té
Terminalia catappa L.		Almendro
	Cochlospermaceae	
Cochlospermum vitifolium (Willd) Spreng.		Pochote
	Elaeocarpaceae	
Muntigia calabura L.		Capulín
	Esterculiaceae	
Guazuma ulmifolia		Pixoy
	Euphorbiaceae	
Croton sp.		Cascarillo grueso
Croton sp.		Cascarillo menudo
Jatropha curcas L.		Polmoché
Sapium macrocarpum M. Arg.		Pozol agrio
(?)		Yaití
	Guttiferae	
Calophyllum brasiliense Camb		Barí
	Lauraceae	
Nectandra sanguinea		Laurelillo
Ocotea veragensis (Meissn.) Mez.		Pimientillo
Persea americana Mill.		Aguacate
Phoebe sp.		Pimiento
	Malphighiaceae	
Byrsonima bucidaefolia (L.) HBK		Nance agrio
Byrsonima crassifolia HBK		Nance o Nanche
Malpigia sp.		Grosello cimarrón
	Melastomaceae	
Miconia sp.		Cuero de vaca
	Meliaceae	
Cedrela mexicana Roem.		Cedro
Swietenia macrophylla King		Caoba
Trichilia cuneta Radlk		Cedrillo

Mimosaceae	
Acacia angustissima (Mill) Kuntze	Kantemó
Acacia collinsii Staff.	Cornezuelo
Acacia dolichostachya	Subín o guacamayo
Acacia sp.	Kaxín
Acacia sp.	Garrobo
Calliandra tonduzii (Br. et Rose) Standl.	Tamarindo cimarrón
Enterolobium cyclocarpum (Jacq.) Griseb	Pich
Inga sp.	Vix
Lysiloma bahamensis Benth	Tza'alam
Pithecolobium calostachys	Tocúy
Pithecolobium sp.	Chukún
Mirtaceae	
Eugenia axilaris (Sw) Willd	Escobillo
Eugenia sp.	Huesillo
Psidium guajaba L.	Guayaba
Psidium sartorianum (Berg) Nied.	Guayabillo
Moraceae	
Artocarpus altilis (Park) Fosb	Arbol del pan
Brosimum alicastrum Sw.	Ramón
Castilla elastica Cerb.	Hule
Cecropia peltata Cerb.	Guarumo
Chlorophora tinctoria (L.) Gaud.	Mora
Ficus cotinifolia	Aguacatillo
Ficus sp.	Copó
Ficus sp.	Chimón
Ficus sp.	Higuillo
Pseudolmedia oxyphyllaria D. Sm.	Mamba
Trophis racemosa (L.) Urb.	Ramón colorado o chaco
Polygonaceae	
Coccoloba cardiophylla	Bolchichillo
Coccoloba schiedeana Lindau	Bolchiche
Coccoloba sp.	Uvero
Coccoloba uvifera L.	Uva de mar
Papilionaceae	
Erythrina glauca Willd	Madre de cacao
Gliricidia guatemalensis Mich.	Cocoite negro
Gliricidia sepium (Jacq.) Steud.	Cocoite blanco
Lonchocarpus castilloi Standl.	Machiche
Lonchocarpus rugosus Benth.	Kantsín
Lonchocarpus sp.	Gusanillo
Myroxylon balsamum (Royle) Harms	Nava o balsamo
Piscidia piscipula (L.) Sarg.	Jabín
Platymiscium yucatanum	Granadillo
Sweetia panamensis Benth	Cencerro
Rhamnaceae	
Krugiodendron ferreum (Vahl) Urban	Chintoke

	Rhizophoraceae	
Rhizophora mangle L.		Mangle colorado
	Rubiaceae	
Alseis yucatanensis		Tabaquillo o papelillo
Blepharidium mexicanum Standl.		Popistle negro
Cosmocalys spectabilis Standl.		Tabasché
Exostema mexicanum A. Gr.		Chactekoc o palo de rosa
Psychotria sp.		Popistle blanco
Randia sp.		Limoncillo
	Rutaceae	
Zanthoxylum procerum D. Sm.		Cola de lagarto
Zanthoxylum sp.		Sinanché
	Sapindaceae	
Sapindus saponaria L.		Jaboncillo
Talisia olivaeformis (HBK) Radlk		Guaya
	Sapotaceae	
Achras zapota L.		Sapote o Chico sapote
Calocarpum sapota (Jacq.) Merril		Mamey cimarrón
Chrysophyllum cainito L.		Caimito
Chrysophyllum mexicanum Brondeg		Caimitillo
Dipholis salicifolia (L.) A. DC.		Sapote Faisán
Lucuma campechiana HBK		Canishté
Sideroxylon sp.		Sapotillo
	Saurauiaceae	
Sauravia spp.		Chakahuanté
	Simarubaceae	
Alvaradoa amorphoides Liebm.		Visiník
Simarouba glauca D.		Pa'asak o ciruelillo
	Tiliaceae	
Belotia mexicana (D.C.) Sch.		Majahua palencana
Leuhea speciosa Willd.		Guacimo
	Ulmaceae	
Ampelocera hottlei Standl.		Luín
Trema micrantha (L.) Blume		Capulincillo
	Verbenaceae	
Vitex gaumeri Greenm		Ya'axnik

ARBOLES NO IDENTIFICADOS

Aceituna
Arrocillo
Ballo
Cabello de Angel
Cabeza de Mico
Cachuché
Canasín
Colcho
Chascarrillo o Palo del Sol
Mamey Santo Domingo
Morgao Blanco
Morgao Negro
Naranjillo
Palo de Sangre
Palo Prieto
Palo Santo
Quebracho
Sabasché

Chaschín
Granada cimarrona
Ebano
Jabín de Agua
Jolché
Kamchám o Palo de Petroleo
Laurel
Leche de Gallo o Copal Colorado
Lomo de Lagarto
Sapote Bobo
Saragua
Tauché
Tela de Cebolla
Tepesquite
Tínco
Trementino
Verde Lucero
Vinagrillo

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Height Growth of Bigleaf Mahogany [1]

By
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Institute of Tropical Forestry

SUMMARY

Bigleaf mahogany plantations in Puerto Rico were studied to determine relationships to selected site variables. A significant correlation of tree height was found with mean diameter and depth of the A_1 soil horizon. No correlation was found with age, competition index, location, drainage, slope, or aspect.

RESUMEN

Se hicieron estudios sobre plantaciones de caoba de hoja grande en Puerto Rico para determinar las relaciones con sitios variables seleccionados. Se encontró una correlación significativa de la altura de los árboles con el diámetro medio y la profundidad del horizonte A_1 del suelo. No se halló correlación alguna con la edad, índice de competición, localización, drenaje, ondulación o aspecto.

Height growth in bigleaf mahogany (*Swietenia macrophylla* King) plantings in the Luquillo and Río Abajo forests in Puerto Rico was studied to determine its relationship to selected site variables. In the Luquillo Forest the stands are located at elevations ranging from 200 to 1300 feet and receive an annual rainfall of 90 to 140 inches. The stands in the Río Abajo Forest are located at elevations ranging from 900 to 1100 feet and receive an annual rainfall of 70 to 90 inches. All plantations are approximately 25 years old.

Thirty-eight plots were measured, nineteen in each forest. Each plot contained at least six bigleaf mahogany trees and was apparently uniform in slope, aspect, and surface drainage. The site variables, and the degree to which they were measured, were the following:

A_1 horizon texture[2]	clay clay humus granular clay humus
A_1 horizon depth	nearest ¼ inch
B horizon texture	clay clay loam
Reaction at 14 inches	pH to nearest tenth
Drainage	very well drained well drained moderately well drained
Slope	nearest one per cent
Aspect	nearest 22.5 degrees

1/ The field work on which this paper is based was done during the 1962 Syracuse Forestry Summer Course, conducted by New York State University College of Forestry at Syracuse, in cooperation with the U. S. Forest Service Institute of Tropical Forestry.

2/ The surface soil horizon containing incorporated organic matter.

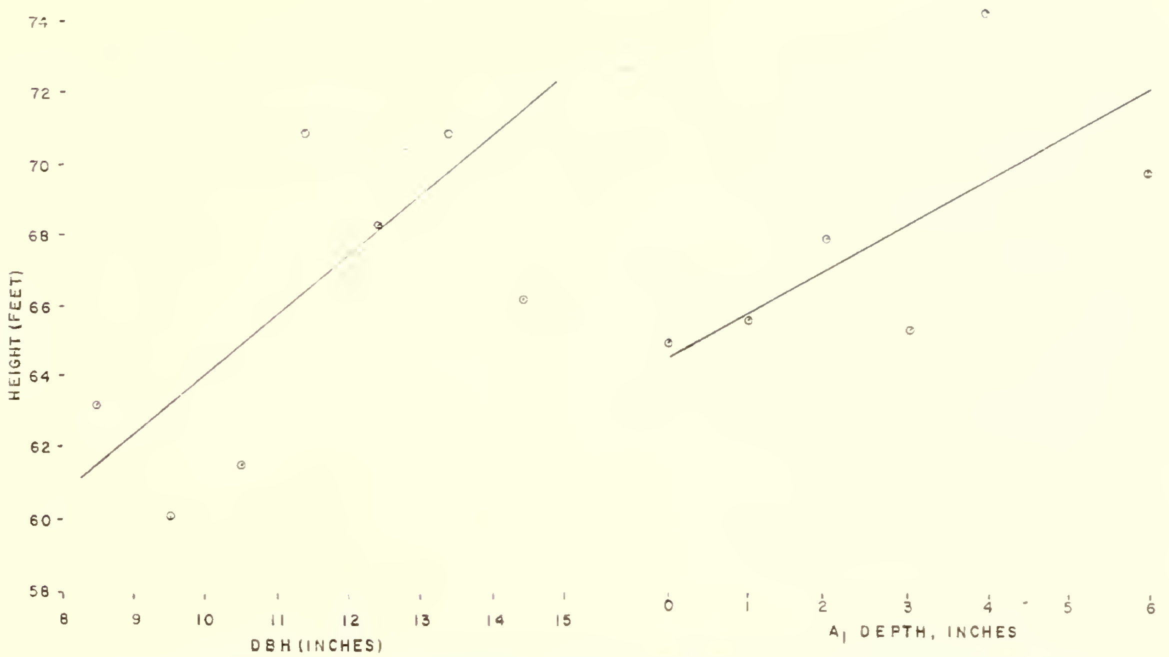

Figure 1. Height of bigleaf mahogany. Line represents computed relationship; circled points represent actual mean values. Left: Height related to diameter breast high. Right: Height related to depth of the A_1 soil horizon.

In addition to this information crown position, diameter at breast height, and total height of each mahogany tree were recorded. Also, an index of competition was obtained by dividing the sum of the basal areas of overtopping trees by the basal area of the crop tree.

The data for each plot were then summarized. Plot mean tree height was tested by regression analysis for correlation with age, diameter, competition index, and gross climatic and geographic differences between Luquillo and Río Abajo forests. Only with diameter was the correlation statistically significant, Figure 1. Tree heights, adjusted to plot mean diameter, ranged from 57 to 76 feet with a mean of 67 feet.

A second regression analysis, using drainage, slope, aspect, and depth of the A_1 horizon as the independent variables, was made for adjusted height. Depth of the A_1 horizon was the only variable with which height was significantly correlated (at the 95 per cent confidence level) and accounted for only one-tenth of the variation in adjusted heights. Within the observed range of A_1 depths from 0.0 to 3.0 inches, each increase of one inch was associated with an increase in tree height of 2.1 feet, Figure 1.

Three possible explanations for the correlation of tree height with depth of A_1 are: (1) that the A_1 horizon is a valuable nutrient source in itself and directly contributes to site productivity; (2) that the A_1 depth is an effect rather than a cause of site productivity, i.e., a more productive site would have produced more organic matter, thus forming a deeper A_1 layer than would a less productive site; and (3) that the depth of the A_1 horizon is an indirect measure of past land use intensity which may have changed physical structure, chemical composition, or effective depth of soil all of which may affect mahogany height growth.

Ninety per cent of the variation in the corrected heights still remains unaccounted for. Untested factors which might account for at least part of this variation are: competition upon the trees in the initial years following planting, genetic differences, and effective depth of soil.

Weedkillers for the Control of Pentaclethra Macroloba and Alchornea Subglandulosa

By

L. KASASIAN

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SUMMARY

Four herbicides were applied to **Pentaclethra macroloba** and **Alchornea subglandulosa** in Trinidad. All the herbicides prevented regrowth from stumps applied basally; 2,4,5,-T provided the greatest kill.

RESUMEN

Cuatro herbicidas fueron aplicados a **Pentaclethra macroloba** y **Alchornea subglandulosa** en Trinidad. Todos los herbicidas impidieron el rebrote en los tocones y la solución 2,4,5,-T produjo la mayor mortalidad.

Pentaclethra macroloba and *Alchornea subglandulosa* are common tree weeds in forest areas in certain parts of Trinidad. As both tend to sucker profusely when cut back, four weedkillers were tested to see if they would afford a satisfactory means of control, when applied as stump or basal bark treatments.

The herbicides used were:

(1) 2,4-D-butyl ester (Fernesta) as a 1% (acid equivalent) solution in diesel oil.

(2) 2,4,5-T mixed esters (Trioxone) - 1% (acid equivalent) in diesel oil.

(3) 2,4,5-TP - propylene glycol butyl ether ester (Kuron) - 1% (acid equivalent) in diesel oil.

(4) Ammonium sulphamate (Ammate) - 50% (active ingredient) aqueous solution + 0.1% Agral 90 (a non-ionic wetter).

Bark treatments were applied to the basal 18-24 inches of the stem, in an amount sufficient for a little of the spray to run-off the bark into the soil.

In the stump treatments, which were made immediately after cutting, both the cut surface and bark were wetted to run-off. The treatments were applied early in the wet season, when rainfall is heavy.

From Table 1, which summarises the results obtained, it will be seen that all the compounds prevented regrowth from the stumps. When applied basally 2,4,5-T was much the best treatment, particularly on *Alchornea*. All the *Alchornea* were already dead and being invaded by termites within six months, but only one of the *Pentaclethra* had died. After 13 months, however 5 of the 6 *Pentaclethra* were dead and the remaining tree was distinctly unhealthy and will probably die.

Table 1. *Herbicide effects*

		Pentaclethra macroloba								*Alchornea subglandulosa*							
		Months after treatment 6				13				Months after treatment 6				13			
		Healthy	? Healthy	Dead or no stump regrowth	Not found 1/	Healthy	? Healthy	Dead or no stump regrowth	Not found 2/	Healthy	? Healthy	Dead or no stump regrowth	Not found 2/	Healthy	? Healthy	Dead or no stump regrowth	Not found 2/
2,4-D	stump			6				3	3			6				6	
	basal	4	2			1	2	3		1	1	4		1		3	2
2,4,5-T	stump			6				4	2			6				4	2
	basal	1	3	1	1		1	5				6				5	1
2,4,5-TP	stump			5	1			5	1			5	1			6	
	basal	5	1			4		2			4	2			2	3	1
Ammate	stump			6		1		4	1		1	5				4	2
	basal	3	1		2	3			3	5			1	5		1	
CONTROLS (Untreated stumps)				1	1	1		1		1		1				1	1

1/ All trees not located at 6 months were located at 13 months and found to be dead, with the exception of those treated basally with ammate.

2/ Those not located at 13 months were all located at 6 months when all stump treatments were recorded as showing no regrowth and all basal treatments (except for ammate) were recorded as dead; it therefore seems likely that the trees had rotted by the later date and that these should be included in the column "dead".

The 1962 Tropical Forestry Short Course

By

H. BARRES, TRAINING OFFICER

Institute of Tropical Forestry

The ninth Tropical Forestry Short Course was conducted at the Institute of Tropical Forestry from September to November, 1962. It provided three months of intensive training in the general field of forestry in the tropics to fourteen participants. They represented six countries in the tropics: British Guiana, Dominican Republic, Jamaica, Liberia, Sierra Leone, and Vietnam.

The course covered the following fields: dendrology, ecology, surveying, inventory, aerial photo interpretation, silviculture, management, protection, and utilization. For a more detailed description of the material covered, see the Caribbean Forester, Vol. 23, No. 1, Report on 1961 Tropical Forestry Short Course. The program was essentially the same as in 1961.

Fig. 1. Participants in the 1962 Tropical Forestry Short Course. Left to Right and Back to Front: D. H. Nho, A. Betancourt, R. I. Mota, D. S. Togba, J. Angleró, J. J. Williams, J. I. Fañas, A. A. Ovalle, L. C. Heang, O. Thuok, A. O. Miller, J. S. Tiah, T. V. W. Bennett, A. S. Musa, J. W. Meikle, C. Soutuon, A. D. Nimley, J. I. González, and P. A. Durán.

The Agency for International Development (AID) of the United States financed the course. The Institute of Tropical Forestry, U. S. Forest Service, Department of Agriculture, provided the personnel. The Food and Agriculture Organization of the United Nations donated literature and the services of Dr. M. A. Huberman, FAO regional Forestry Officer. Other agencies of the U. S. Government and the Puerto Rican Commonwealth participated.

The participants were: J. W. Meikle (Britist Guiana); P. A. Duran F., J. I. Fañas R., J. I. González V., R. I. Mota R., A. A. Ovalle M. (Dominican Republic); T. V. W. Bennett, A. O. Miller (Jamaica); A. D. Nimley, J. S. Tiah, D. S. Togba (Liberia); A. S. Musa, J. J. Williams (Sierra Leone) and D. H. Nho (Vietnam).

Experiencias de Riego por Infiltración Subterránea En Almácigos de Pinos y Eucaliptos

Por
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Jefe del Vivero Provincial I.P.A.A.C.
República Argentina

RESUMEN

Se describen varios ensayos de infiltración subterránea llevados a cabo con el fin de tratar de simplificar los métodos de riego en almácigos de pinos y eucaliptos. Varias de las ventajas logradas con este tipo de riego son: una sola persona puede encargarse del riego; el terreno se apelmaza menos; los riegos resultan más homogéneos con mejor distribución de la humedad y de mayor duración; la germinación es más rápida y pareja; y probablemente el control de la enfermedad de los almácigos (damping-off) resulte más fácil.

SUMMARY

Various tests of underground irrigation in pine and eucalypt nurseries are described to simplify the irrigation methods. Some of its advantages are: a single person can take care of it; soil does not get so compact; irrigation is more uniform yielding a more lasting and better distribution of moisture; germination is faster and more even; and control of damping-off is probably easier.

El riego por infiltración subterránea consiste en suministrar el agua humedeciendo las capas inferiores de la tierra, la que luego ascenderá por capilaridad a la superficie, en lugar de regar directamente sobre esta.

Nuestras experiencias se iniciaron con el propósito de simplificar las tareas de riego de almácigos y además conseguir algunas ventajas, entre ellas:

a) Menos jornales insumidos en riegos, ya que sólo un hombre podría encargarse del mismo;

b) La tierra se apelmaza menos que en los almácigos regados con regaderas o por inundación superficial, al llevarse la humedad de abajo hacia arriba;

c) Los riegos podrían ser más homogéneos, con mejor distribución de la humedad y de mayor duración, lo que no haría necesario hacerlos diariamente;

d) La germinación en estas condiciones, sería más rápida y pareja, y menor la invasión de malezas por utilizarse tierra zarandeada; así el desarrollo de la plántula en esta clase de tierras podría ser más rápido.

e) Probablemente el control de la enfermedad de los almácigos (damping-off) resulte más fácil, ya que la plantita no está en contacto directo con un exceso de agua de riego.

MATERIALES Y METODO

LUGAR

Vivero Forestal dependiente del Instituto Provincial de Asuntos Agrarios y Colonización (I.P.A.A.C.) en la ciudad de Río Cuarto, Provincia de Córdoba, República Argentina.

ESPECIES UTILIZADAS

Pinus radiata, P. halepensis y Eucalyptus viminalis.

SUELO

Arenoso-franco. (Con bastante porcentaje de arena fina).

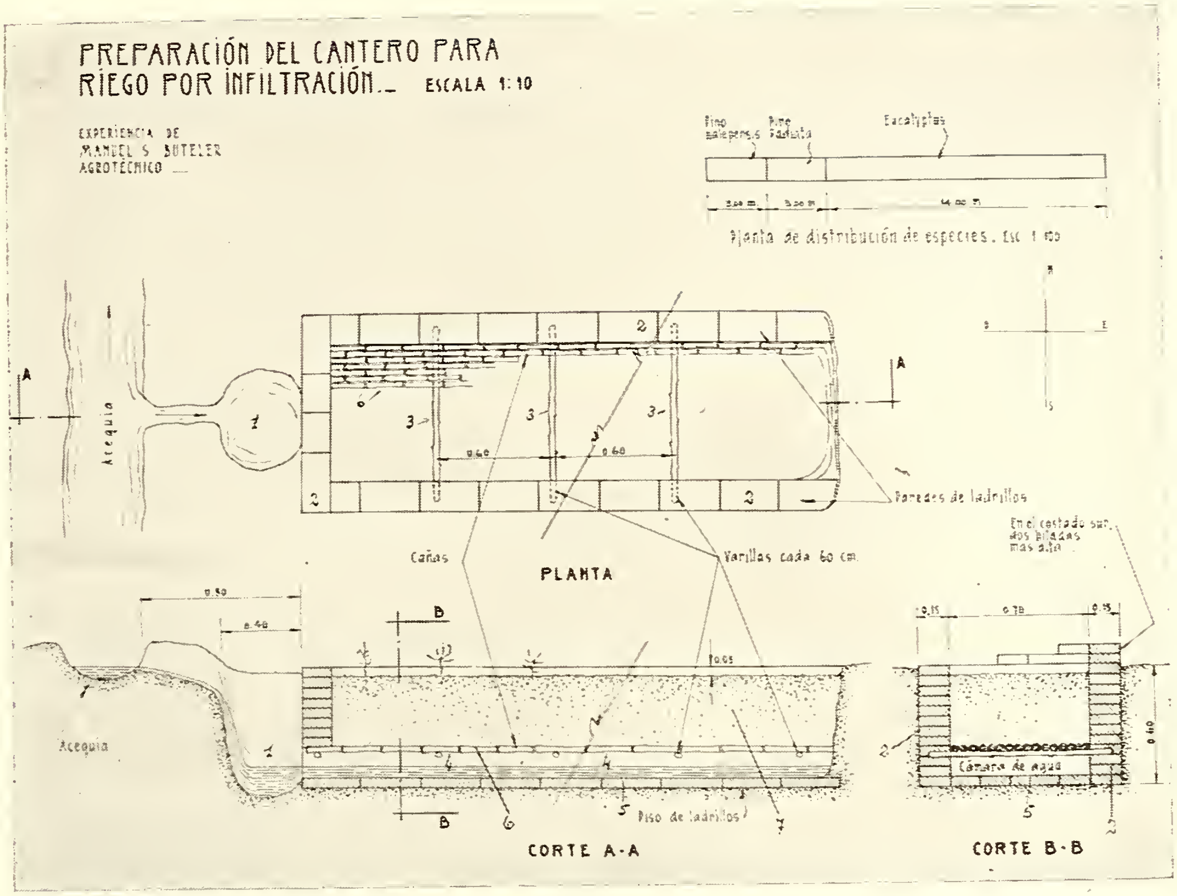


Figura 1. Preparación del canterc para riego por infiltración.

PODER GERMINATIVO

Pinos - 75%

Eucalyptos - 70%

FECHA DE SIEMBRA

Agosto de 1960.

CONTROL DE PLAGAS

Pinos: Se esterilizó la tierra 24 horas antes de la siembra con ácido sulfúrico al 10%. La semilla se trató con "Uspulum" Bayer en seco, hasta cubrirla con una delgada capa.

Eucaliptos, sin tratamiento.

GERMINACION

Pinus radiata a los 20 días; *P. halepensis*, siete días después.

Los eucaliptos a los 12 días.

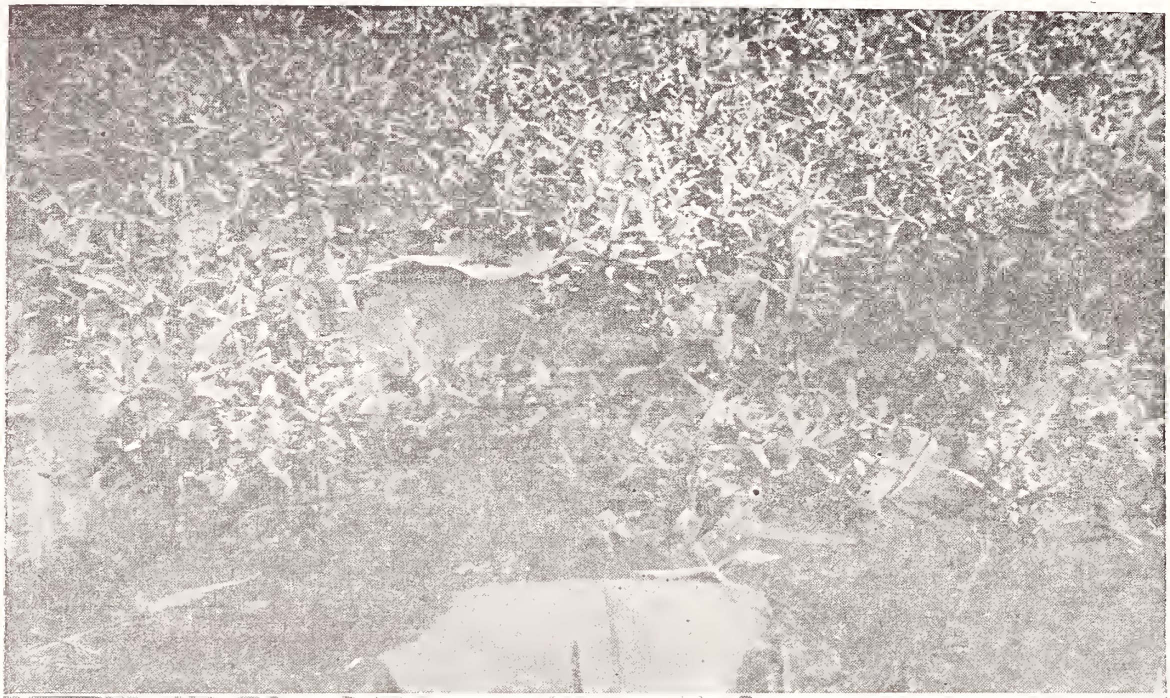
1/ El número indicado en la ilustración.

PREPARACION DEL ALMACIGO Y MEDIDAS

Se prepararon tres canteros orientados de este a oeste con ancho de 0,70 metros; dos para pinos de 3 metros de largo y uno para eucaliptos de 14 metros de largo.

Estos fueron preparados de la siguiente forma según se ilustra en la Figura 1.

A partir del nivel del fondo de una acequía de riego, se hizo una excavación de 0,60 m. de profundidad, 1 metro de ancho por el largo de los canteros; nivelando bien el fondo, se colocó sobre él un piso de ladrillos sueltos (5)[1/], y encima de éste y a ambos costados de la zanja, se ubicó dos hiladas de ladrillos (2)[1/], también sueltos, formando pared de 0,15 m. y apoyadas sobre ambas paredes se instalaron varillas (3)[1] separadas entre sí por 0,60 m.; apoyándose en estas varillas, se colocó un piso de cañas de castilla,



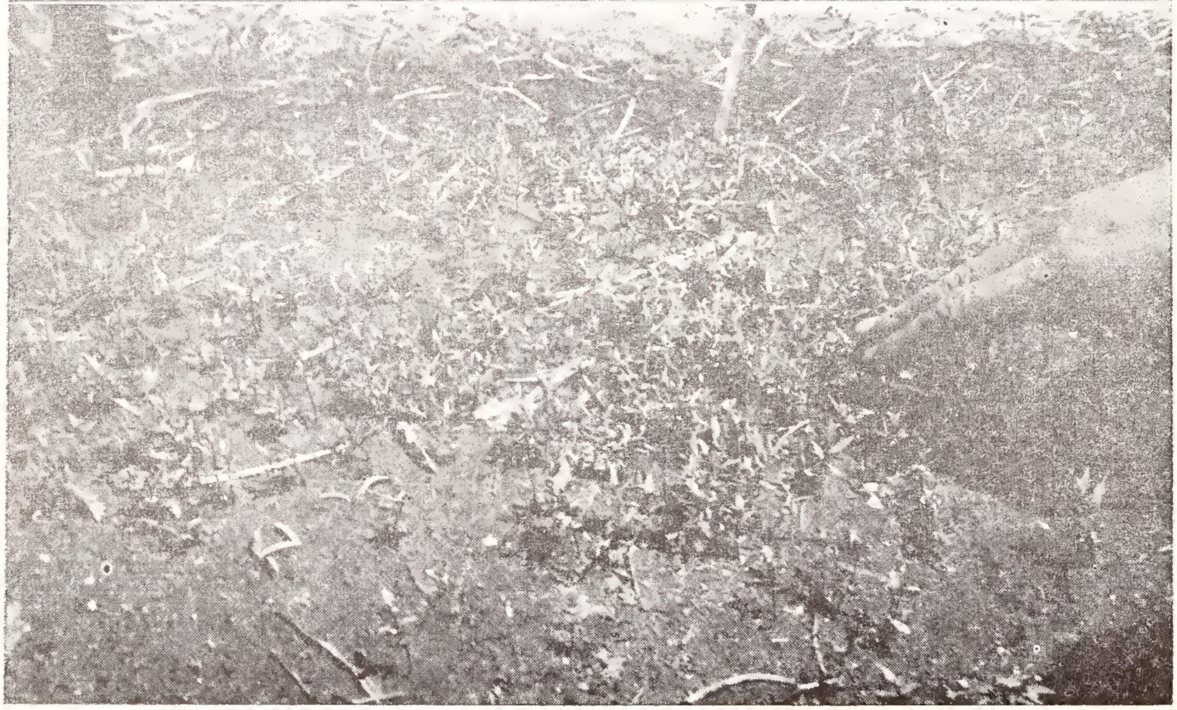


Figura 2a. Eucaliptos sembrado el 26/8 regados por infiltración.
Fotografías tomadas dos meses de germinados.

Figura 2b. Eucaliptos sembrados el 27/8 y regados por aspersión.

Arundo donax (6)1/, aún cuando puede usarse otro material que cumpla la misma función de permitir el paso del agua. Una vez colocadas las cañas se completaron las paredes (2)1/ de ladrillos hasta alcanzar la altura de 0,60 metros. A una de las paredes se le añadió dos hileras más de ladrillos, que actuarán como reparo. Así preparado, el cantero se rellenó con tierra zarandeada hasta 5 cm. del borde, el que se emparejó y apisonó de forma tal que la superficie del almácigo, quedó al mismo nivel del fondo de la acequia. Entre ésta y el cantero debe haber una separación de por lo menos 0,80 metros para preparar un pequeño sifón (1)1/ que aminore la velocidad del agua. Después de preparado y nivelado en la forma expresada y con el objeto de que la tierra se humedeciera y se compactara se le dió el primer riego por infiltración subterránea, procediéndose luego a rellenar las depresiones que se hubieran producido.

Esta construcción se estima que puede durar tres años; esta duración está condicionada al deterioro de las varillas y las cañas, las que se pueden cambiar a un costo ínfimo cada tres años, o sinó reemplazarse por otro material más resistente y durable.

RESULTADOS PRELIMINARES

SIEMBRA DE PINOS

En tierra debidamente preparada y en buen estado de humedad se marcaron surcos cada 10 cm.; con la palita sembradora marca "Pis-sem" se hicieron los surcos de 2 ó 3 cm. de profundidad; también a cada 10 cm., se depositaron de 2 a 3 semillas, las que se cubrieron con la palita. Luego se zarandeó una delgada capa de mantillo vegetal, y entonces se procedió a dar un riego por infiltración subterránea, comprobándose en esta oportunidad que el mismo no resultó parejo, y por tal causa se salvó la deficiencia regando con regadera hasta la aparición de las plántulas en el cantero de *Pinus halepensis*.

Los posteriores riegos por infiltración subterránea se suministraron con una periodicidad de uno por semana.

SIEMBRA DE EUCALIPTOS

Se efectuó en tierra sin tratar y al voleo, sobre cantero preparado en las mismas condiciones que para los pinos, cubriéndose la semilla con una delgada capa de mantillo vegetal, (puede ser necesario dar un riego liviano, por aspersión con "flor" muy fina con el objeto de asentar el mantillo). Después de efectuada la siembra se procede a suministrar un riego por infiltración subterránea hasta que la humedad se manifieste en la superficie, lo que ocurre a los 25 ó 30 minutos. Posteriormente el almácigo se tapa con esteras de cañas de castilla.

En esta experiencia, dada la pequeñez de la semilla, se complementó el riego por infiltración con riegos livianos por aspersión para favorecer el comienzo de la germinación y únicamente en el período mencionado (4 a 5 días) ya que después no fueron necesarios.

Hay que cuidar que el riego subterráneo no sea excesivo porque el agua puede rebalsar por encima del cantero y producir daños por arrastre de semillas; para canteros de estas dimensiones (20 m. en total de canteros) y en estas clases de suelos, 20 ó 30 minutos de riego son suficientes.

REPETICION DE LOS ENSAYOS

Habiendo sido los primeros resultados satisfactorios, se preparó otro cantero en la misma forma descrita anteriormente, pero esta vez vigilando cuidadosamente la nivelación, en los diferentes pasos de su construcción, utilizando, para ello una regla y un nivel de albañil. Al efectuar el primer riego, éste resultó más regular en toda la superficie, por lo que se procedió al día siguiente a sembrar *Pinus radiata* y *Eucalyptus viminalis*; los primeros en un cantero de 3 por 0,70 metros, y los eucaliptos en otro de 17 metros:

1/ El número indicado en la ilustración.

el almácigo se tapó únicamente con esteras de cañas de castilla. Esta siembra fue hecha en tierra sin tratar, con el objeto de observar si se producían y en que intensidad ataques de "damping-off", que en la siembra anterior con semillas y tierra tratadas fue casi nulo.

La germinación en ambos casos fue homogénea, pero de igual modo se registraron ataques de esta enfermedad, según se menciona más adelante en las conclusiones.

Pudo comprobarse que los almácigos tapados con coberturas de polietileno conservaron mejor la humedad, al condensarse debajo de ellas el vapor de agua, que de otro modo habría escapado a la atmósfera.

CUADROS COMPARATIVOS

RESULTADOS OBTENIDOS EN LA GERMINACION DE LOS ALMACIGOS DE PINOS Y EUCALIPTOS SEGUN SISTEMAS DE RIEGOS

Especie	Sistema de Riego 1/	Sistema w de Siembra	Fecha de Siembra 1960	Fecha de Germinación 1960	Período de Germinación Días
P. halepensis	infiltración	líneas	25/8	22/9	27
P. radiata	infiltración	líneas	25/8	15/9	20
E. viminalis	infiltración	voleo	26/8	7/9	11
E. viminalis	aspersión	voleo	27/8	14/9	17
P. halepensis	aspersión2/	líneas	3/9	4/10	32
P. radiata	infiltración	líneas	28/9	17/10	19
E. viminalis	infiltración	voleo	28/9	3/10	5

1/ Los riegos por aspersión se hicieron diariamente. Los riegos por infiltración se hicieron semanalmente.

2/ La tierra se trató con ácido sulfúrico al 10% y la semilla con "Uspulum".

GRAMOS DE SEMILLAS SEMBRADAS Y NUMERO DE PLANTAS OBTENIDAS EN AMBOS ALMACIGOS SEGUN EL SISTEMA DE RIEGO EMPLEADO

	Superficie del almácigo en m^2		Semillas Sembradas en Gramos		Plantas obtenidas para repique		Semillas sembradas por m^2. Gramos	
	Infilt.	Asper.	Infilt.	Asper.	Infilt.	Asper.	Infilt.	Asper.
P. halepensis	2,10	6,00	16	72	507	1.141 1/	8	12
E. viminalis	9,80	7,00	350	350	8.768 2/	7.064	36	50

1/ El almácigo de pinos regados por aspersión fué utilizado para experimentar la pala tubular de trasplante, original del autor.

2/ Este almácigo se inundó el 3 de septiembre, hasta rebalsar por la mitad del mismo, arrastrando la semilla en una longitud de tres metros, lo que mermó la cantidad de plantas obtenidas para el repique.

TIEMPO EMPLEADO POR UN OBRERO PARA REGAR AMBOS ALMACIGOS DESDE LA SIEMBRA HASTA EL REPIQUE

	Fecha de Siembra		Fecha de Repique		Número de Riegos		Total de minutos empleados en Riegos	
	Infilt.	Asper.	Infilt.	Asper.	Infilt.	Asper.	Infilt.	Asper.
Pinos	25/8/60	3/9/60	15/1/61	15/3/61	20	161	500	966
Eucaliptos	26/8/60	27/8/60	22/12/60	26/1/61	16	150	400	900

El tiempo de cada riego por infiltración subterránea fué de veinte y cinco minutos semanales.

El tiempo de cada riego por aspersión fué de seis minutos diarios.

CONCLUSIONES

El mayor costo habido en la preparación del cantero por el método descri'o está plenamente justificado por las siguientes ventajas:

1. Economía de jornales en los riegos. Solo se requiere un hombre, una vez por semana, cuya tarea se limita a controlar la cantidad de agua necesaria para cada almácigo.

2. Menor apelmazamiento de la tierra. El riego de abajo hacia arriba evita la compresión del terreno y la formación de costras superficiales.

3. La germinación es más rápida y pareja por la mejor distribución de la humedad.

4. El desarrollo de las plántulas es más rápido, y se obtienen plantas para el repique antes que en los almácigos regados por aspersión.

5. El ataque de la enfermedad de los almácigos (damping-off), parece ser menor, estimándose que será fácil su control, debido a que las plántulas no están en contacto con un exceso de agua de riego.

En los almácigos de *Pinus halepensis* tratados con ácido sulfúrico y Uspulum Bayer, y regados por aspersión se produjo ataque en un 25%. En la siembra de *Pinus radiata*, sin tratamientos, se observaron ataques del 30 al 40%. Se hace notar que la germinación de pinos coincidió con una temporada de lluvias y días nublados. En los eucaliptos no se apreciaron ataques.

AGRADECIMIENTOS

A las autoridades del Instituto Provincial de Asuntos Agrarios y Colonización y al Jefe del Departamento Técnico del mismo, por el apoyo prestado a estas experiencias. Al Ingeniero Agrónomo Fernando Castro Corbat, Jefe de la Agencia de Extensión, local de I.N.T.A., igual que a todo el personal técnico de la misma. Al Agrotécnico Carlos Brisighelli, por la colaboración prestada.

Variation of Stand Structure Correlated with Altitude, in the Luquillo Mountains

By

H. H. WHITE, JR. 1/

SUMMARY

A study was made of changes in stand structure associated with elevations in the Luquillo Mountains of Puerto Rico.

Number of trees per acre increased with elevation. Average height of dominant trees, average diameter, maximum diameter, basal area per acre, and number of species per plot all decreased as elevation increased. Species which predominated also varied with elevation.

RESUMEN

Se hizo un estudio de los cambios ocurridos en la estructura de un rodal asociado con las elevaciones en las montañas de Luquillo en Puerto Rico.

El número de árboles por acre aumentó con la elevación. La altura promedio de los árboles dominantes, el diámetro promedio, el diámetro máximo, el área basimétrica por acre, y el número de especies por parcela, todos disminuían según aumentaba la elevación. Las especies que predominaban también variaban con la elevación.

This study was to determine changes in stand structure correlated with altitude in the Sierra de Luquillo of Puerto Rico. It was intended to limit the study to only the climatic climax type and to avoid taking measurements in edaphic climaxes or lesser successional stages.

The transect lay within the boundaries of the Luquillo Experimental Forest on the northwestern slopes of El Yunque, one of the higher peaks of the Sierra de Luquillo. All measurements were taken within the Subtropical Rain Forest as defined by Holdridge (1958). This study was undertaken in forest stands also known locally as the Colorado and Mossy forest types.

An excellent description of the Mossy Forest type is given by Gleason and Cook (1927). Their book includes lists of many of the tree species as well as those of the lesser vegetation. The Colorado type is discussed together with the Tabonuco type under the heading "Rain Forest." The latter type is found at a lower elevation than the former.

In more recent times the U. S. Forest Service Institute of Tropical Forestry has taken measurements in both types where this study was undertaken. In the Colorado type 53 species were found, and they occur in two canopy layers. *Cyrilla racemiflora* L., *Micropholis garciniaefolia* Pierre, *Calycogonium squamulosum* Cogn., *Ocotea spathulata* Mez., and *Micropholis chrysophylloides* Pierre are the most important species in regard to density, frequency, and dominance. The forest stands of the Colorado type are known to decrease in height with increasing altitude, and eventually form a single canopy level at its highest altitudes.

Where the tree height decreases below 20 feet, the type is usually referred to as the

1/ Prepared as a special report for the 1962 Syracuse Forestry Summer Course, conducted by New York State University College of Forestry at Syracuse, in cooperation with the U. S. Forest Service Institute of Tropical Forestry.

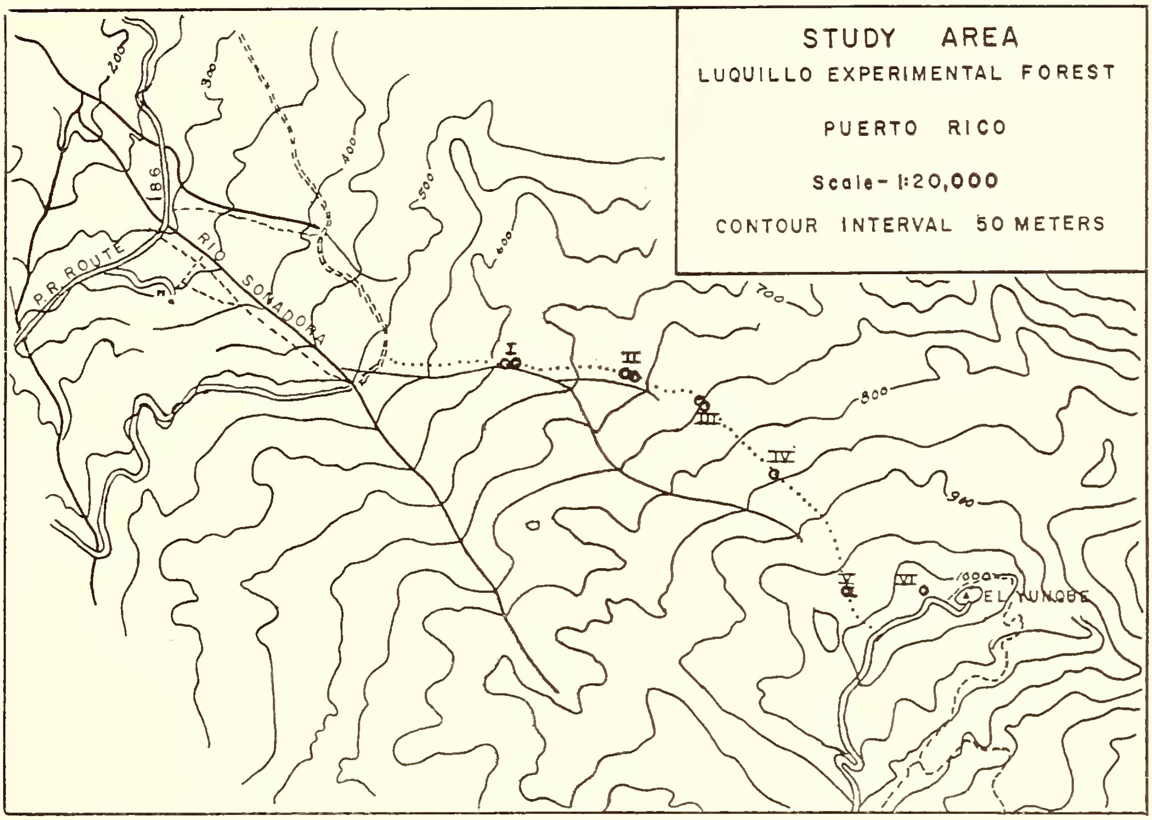


Figure 1. Study area.

Elfin or Mossy Forest. Above this altitude tree height continues to decrease, and tree form becomes increasingly poor. The average diameter has been found to decrease to less than two inches on the more exposed ridges. Wadsworth (1951) stated that the Mossy forest should be considered a subdivision of the Colorado type, as there are no species confined to this type alone. The number of species at the higher elevations is much smaller than below, and Wadsworth indicated that this is a result of the adversity of the exposed environment. Other observations made by Wadsworth (1952) concerning two transects that were made near the summit of El Yunque, showed that *Tabebuia rigida* Urban is by far the predominant tree, both in frequency and in basal area. Other important species that were encountered included *Calycogonium squamulosum* Cogn., *Eugenia borinquensis* Britton, and *Ocotea spathulata* Mez. Eleven species were found on one transect measuring 14 chains by ¼ chains (0.35 acres). *Micropholis garciniaefolia* Pierre was also noted as being prominent in basal area on a transect made between East and West Peaks of the Sierra de Luquillo, but this species was not found in the transects made on El Yunque.

METHODS

The original intention was to make a transect line from El Verde Field Station to the summit ridge of El Yunque, and then to measure tenth-acre plots at 250-foot intervals of vertical elevations, beginning at 1500 feet and ending at 3250 feet. Preliminary reconnaissance indicated that the lowest level where the plots could be established in a relatively undisturbed stand was at an elevation of 2000 feet. Second-growth stands

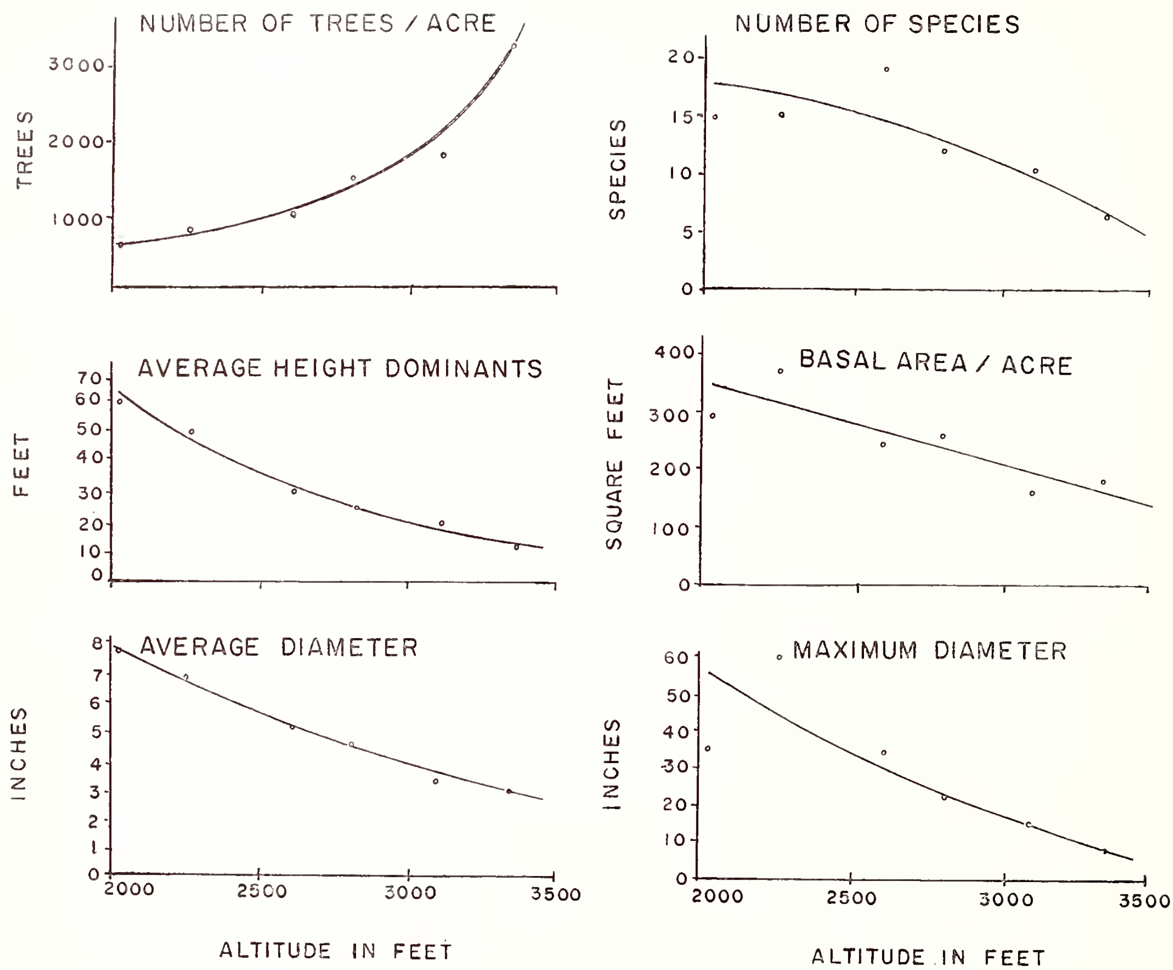


Figure 2. Plot characteristics.

were found almost everywhere below this level.

In order to keep slope, aspect, and other site factors not correlated with altitude constant, the transect line was established along a ridge line, and thus was not a straight line.

Below the 3000-foot level, only small areas of land along the ridge contained the dense forest stands that were considered to be the climatic climax formation. Considerable area had secondary vegetation growing up as a result of windfalls. Thus it was found necessary to shift the plots up or down from the desired 250-foot intervals. Thus plots were finally established at 1960, 2250, 2600, 2800, 3100, and 3350 feet. These altitudes were determined by the use of an anaeroid altimeter and by checking elevations against points of known elevation that could be discerned on the U.S.G.S. topographic map "El Yunque, P. R."

Because of the lack of time available and because of the limited area that contained the climatic climax, it was found possible to establish only two plots for the lowest three elevation levels, and only one for the upper three elevation levels. Plot size was also reduced to 1/20th-acre at the 3350-foot level. It was felt that this reduction in plot area at the higher altitudes was justified because of the greater number of stems per acre.

All plot trees larger than 2.0 inches in diameter at breast height were tallied by

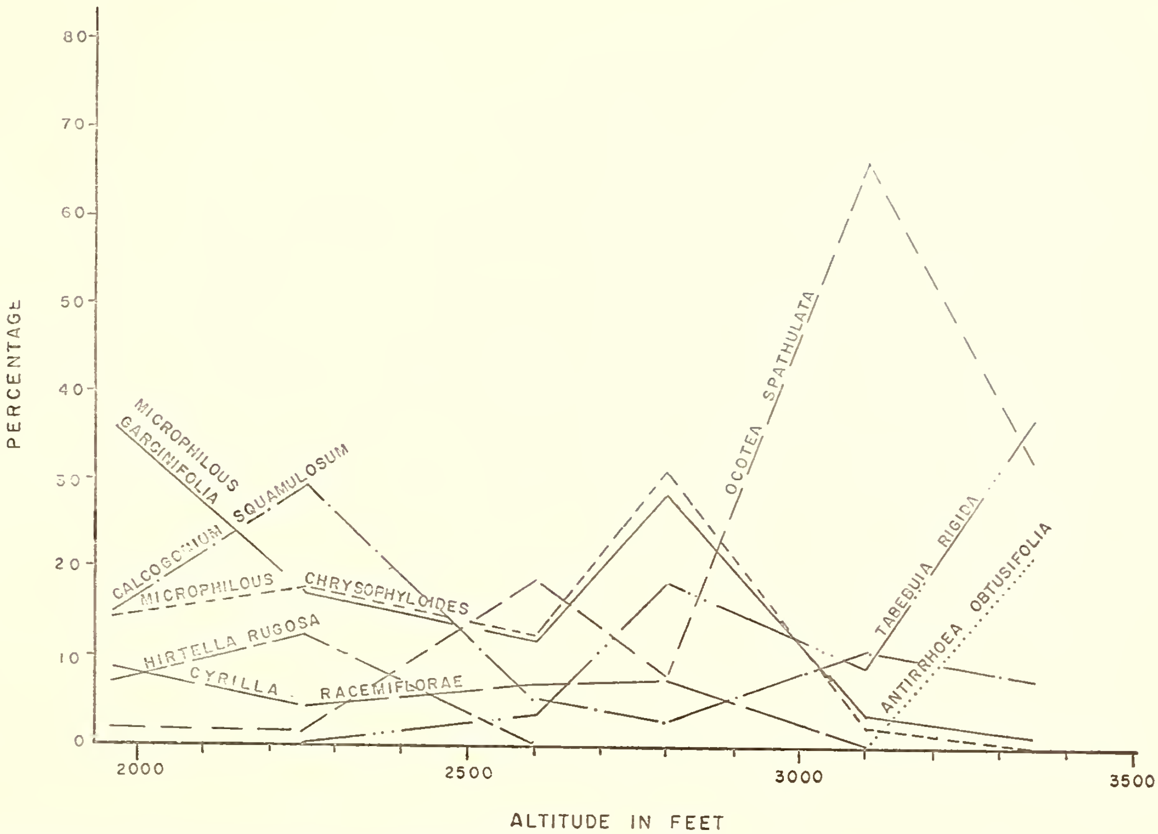


Figure 3. Number of stems by species and altitude.

dbh, species, and crown position. Heights of several dominants on each plot were also measured.

When the field work was completed, some 1000 trees had been measured on a total of 0.85 acres, and a total of 27 species were identified.

DISCUSSION

CURVES OF BASIC MEASUREMENTS

The data from these measurements are summarized by the graphs in Figure 2.

The number of trees per acre increased from 595 at the 1960-foot level to 3240 per acre at the 3350-foot level.

Average height of the dominants decreased from 60 feet at 1960 feet elevation to only 12 feet at 3350 feet elevation. Observations made in the vicinity of the latter level showed that the trees decreased to less than two feet in height around an exposed rock summit to the north of the main summit of El Yunque. Observations made throughout the transect indicated that the decrease in height was quite irregular, and greatly dependent on local exposure. In some plots the heights of the dominants varied considerably, depending on whether they stood on the windward or leeward side of the ridge.

The average d.b.h. of the plots decreased from 7.9 to 3.0 inches as the altitude increased. Maximum plot diameter decreased from 60 to 8 inches.

The basal area curve was the most irregular of the data recorded. However it was apparent that the basal area also decreased as altitude increased, from around 300 square feet per acre at the lower altitudes to 160 square feet per acre at the higher altitudes.

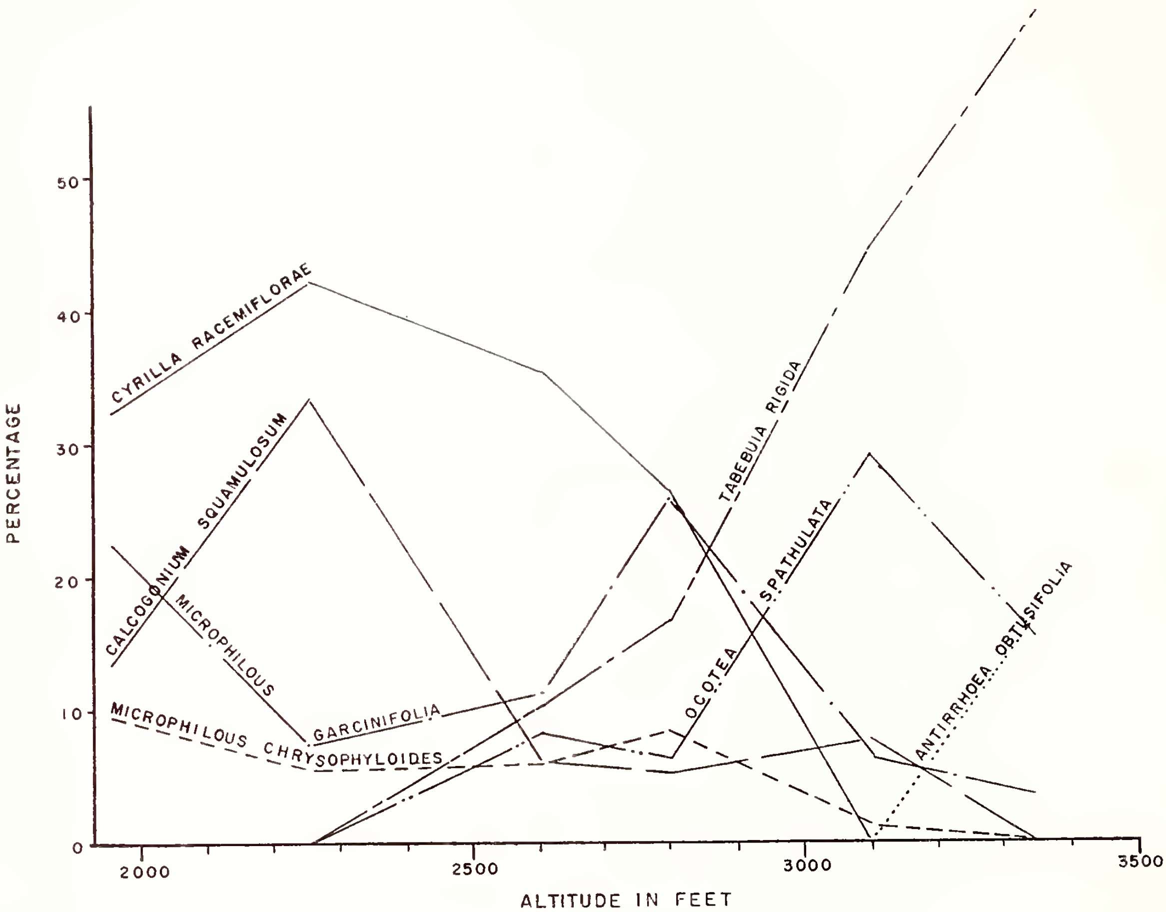


Figure 4. Total basal area by species and altitude.

The number of species decreased from 15 at the lowest level to 6 at the highest level. It should be noted that these figures are based on d'fferent numbers of trees tallied at each altitude; 59, 82, 104, 148, 178, and 162 at elevations of 1960, 2250, 2600, 2800, 3100, and 3350 feet respectively.

ORDINATION OF SPECIES

Two graphs are included to show the ordination of species according to the number of stems and basal area to altitude. The lines on the graphs should only be considered as connecting plot data; the sample was not of sufficient size for interpolation to be made.

Figure 3 shows the frequency distribution of species expressed as a percentage of the total number of stems at the respective altitude levels. Only eight of the twenty-seven species found are shown on the graph; the remaining species occurred only in limited numbers, or at only one altitude. No species shows dominance at the lower altitude levels, but *Ocotea spathulata* and *Tabebuia rigida* showed a marked dominance at the higher altitudes. It can also be seen that most of the species prominent in the Colorado type greatly decreased in frequency at the higher elevations, and some species dropped out completely. Apparently some inconsistency is found on the plot at the 2800-foot level, as there is a seemingly abnormal peak in the frequency of *Micropholis garciniaefolia* and *M. chrysophylloides*, and a depression in the frequency of *Ocotea spathulata*. Some other

environmental factor seems to have masked the effect of altitude at this level.

Figure 4 shows species basal area, expressed as a percentage of the total at each altitude. *Cyrilla racemiflora* remains in a dominant position until an altitude of 2800 feet. Above this elevation, *Tabebuia rigida* becomes dominant.

Records of species by crown classes gave rather indefinite results. Most of the species that showed any trend at all changed from a more dominant class to a less dominant class as altitude increased. *Cyrilla racemiflora* was one exception, remaining in the dominant crown class at all four altitudes where it was found. Another exception was *Ocotea spathulata*, which changed from a lesser crown class to a more dominant one as altitude increased.

CONCLUSIONS

Despite the relatively small number of measurements made, much of the data formed definite trends that can easily be discerned in the graphs. Nevertheless, some irregularities were observed that tended to mask the relationship between altitude and the occurrence of the tree species. Although care was taken to keep all the plots on sites with similar topographic features, slope, and aspect, it seems probable that environmental factors other than those correlated with altitude had an effect on the distribution and frequency of the various species. This seemed especially true at the 2800-foot level.

This type of transect could perhaps best be improved by measuring plots at a greater number of altitudes so that if irregularities were found, the responsible plots could be discarded without greatly decreasing the amount of available data.

SUMMARY OF PLOT DATA

Elevation (Feet)	Plot Size (Acres)	Number of Plots	Number of Trees Per Acre	Height Dominants (Feet)	DBH Average (Inches)	DBH Maximum (Inches)	Basal Area Per Acre (Sq. Ft.)	Number of Species
1960	0.10	2	595	60	7.9	35	300	15
2250	0.10	2	820	50	6.7	60	378	15
2600	0.10	2	1045	30	5.1	35	247	19
2800	0.10	1	1480	25	4.5	22	160	12
3100	0.10	1	1780	20	3.4	15	164	10
3350	0.20	1	3240	12	3.1	8	181	6

LIST OF SPECIES AND FAMILIES

Scientific Name	Family
Antirhea obtusifolia Urban	Rubiaceae
Byrsonima coriaceum (Sw.) DC.	Malpighaceae
Calycogonium squamulosum Cogn.	Melastomataceae
Clusia krugiana Urban	Guttiferae
Cordia borinquensis Urban	Ehretiaceae
Croton poecilanthus Urban	Euphorbiaceae
Cyathea arborea (L.) J. E. Smith	Cyatheaceae
Cyrilla racemiflora L.	Cyrillaceae
Dacryodes excelsa Vahl	Burseraceae
Daphnopsis caribaea Griseb.	Thymelaceae

Euterpe globosa Gaertn.	Palmae
Ficus laevigata Vahl	Moraceae
Haenianthus obovatus Krug & Urban	Oleaceae
Heterotricaum cymosum (Wendl.) Urban	Melastomataceae
Hirtella rugosa Pers.	Amygdalaceae
Ixora ferrea (Jacq.)	Rubiaceae
Magnolia splendens Urban	Magnoliaceae
Matayba domingensis (D.S.) Radlk	Sapindaceae
Meliosma herberti Rolfe	Sabiaceae
Miconia sp.	Melastomataceae
Micropholis chrysophylloides Pierre	Sapotaceae
Micropholis garciniaefolia	Sapotaceae
Myrcia splendens (Sw.) DC.	Myrtaceae
Ocotea leucoxylon (Sw.)	Lauraceae
Ocotea spathulata Mez	Lauraceae
Psychotria sp.?	Rubiaceae
Tabebuia rigida Urban	Bignoniaceae

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The Response of Honduras Pine to Various Photoperiods

By

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SUMMARY

Height growth of Honduras pine (**P. caribaea v. hondurensis**) seedlings is shown to be significantly influenced by photoperiod. Maximum initial effect was obtained by the longest period tested, 16 hours; but by 7 weeks, greatest growth was obtained by an interrupted 11 (8+3) hours.

RESUMEN

El crecimiento en altura de arbolitos de pino hondureño (**P. caribaea v. hondurensis**) se demostró significativamente influenciado por fotoperíodo. Se obtuvo un efecto inicial máximo durante el período más largo de prueba, 16 horas; pero a las 7 semanas se obtuvo un mayor crecimiento durante un período de 11 horas interrumpidas (8+3).

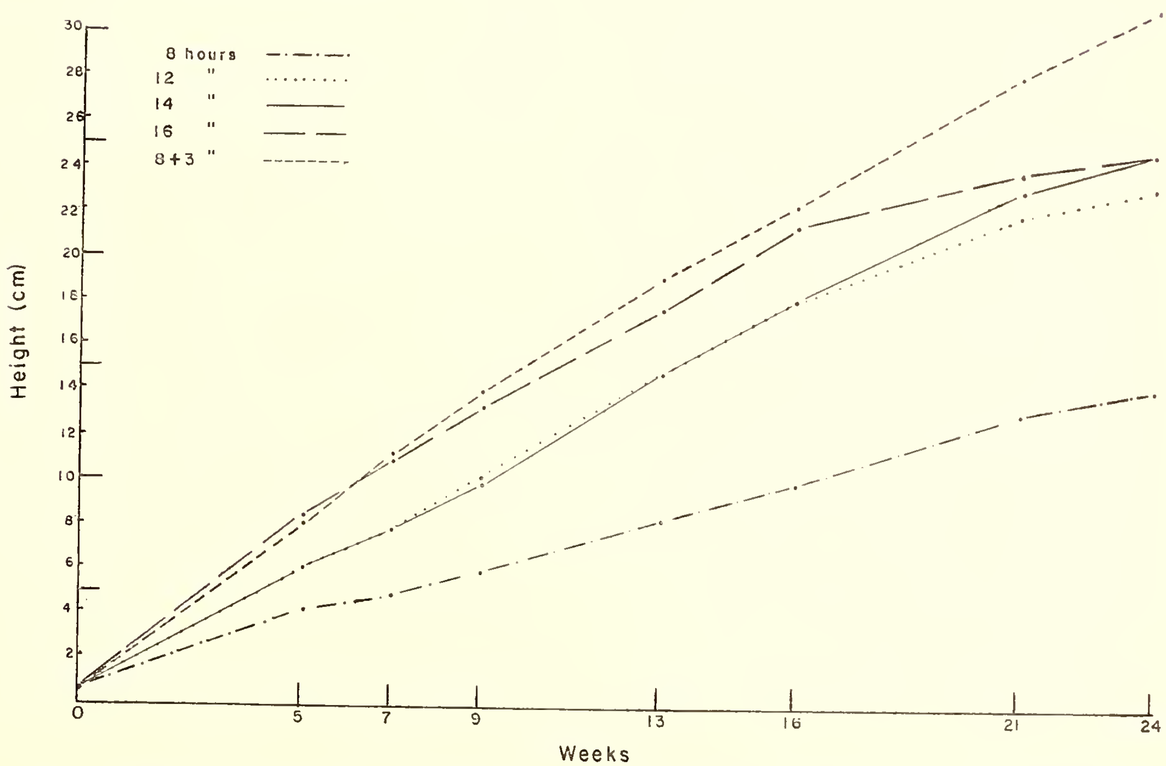

Figure 1. Variation in stem length of Pinus caribaea v. hondurensis with daily photoperiods; means of groups of 15 seedlings.

Figure 2. Comparative heights of Caribbean pine after 30 weeks exposure to 5 different photoperiods. Note that 8-hour day seedling is shorter than the 12-, 14-, and 16-hour seedlings which are shorter than the seedling with 11 hours interrupted light.

Growth and development of Honduras pine (*Pinus caribaea* v. *hondurensis*) exposed to various photoperiods were observed in a study at Beltsville, Maryland, with seed obtained from British Honduras. Approximately 2 months after germination, the seedlings were divided into 5 groups, with the average height of the seedlings approximately the same in each group, Figure 1. Each group was exposed to one of five photoperiods: 8, 12, 14, 16, and 11 hours per day. The 11-hour seedlings received light in two separate periods, as explained below.

Each group of pines was placed on a greenhouse truck for transporting into and out of its appropriate photoperiod chamber.1/ The 8-hour seedlings were moved into the greenhouse at 8 a.m. and into a dark chamber at 4 p. m. Also at 4 p.m., the 12-hour trucks were wheeled into a chamber illuminated by incandescent bulbs (Downs, Borthwick, and Piringer; 1958) and left to 8 p.m.; the 14-hour seedlings were left under incandescent lights until 10 p.m, the 16-hour seedlings to midnight, and the interrupted-light seedlings were in the illuminated chamber from 11 p.m. to 2 a.m. The light intensity within the chambers was 40 footcandles and the minimum temperature was 70°F.

The general effect on Honduras pine of extended photoperiod was to increase both

1/ Photoperiod facilities were provided by R. J. Downs, Plant Physiology Pioneering Research Laboratory, U.S.D.A. Agriculture Research Service, Beltsville, Maryland.

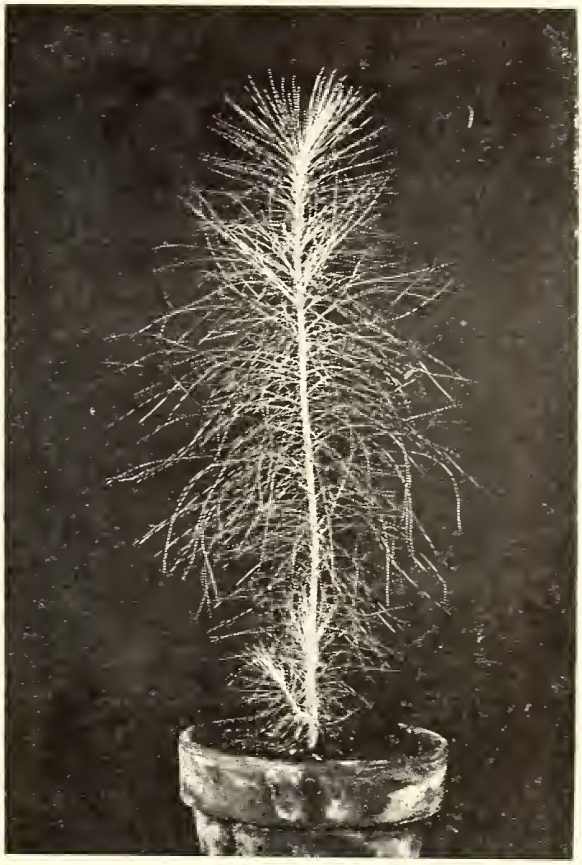

Figure 3. Continuous acicular growth and stem elongation of Caribbean pine. This response was common to all photoperiods.

height growth and production of new needles, Figure 2.

During the first five weeks of treatment height growth for the 16-hour and interrupted 11-hour days were greater than for 12 or 14 hours; these latter were, in turn, greater than for 8 hours. Both differences were significant at the 1 per cent level of confidence.

At the end of 24 weeks the pattern had changed slightly. Growth for the interrupted 11 hours was significantly greater than for 12, 14, or 16 hours, all of which were highly significantly greater than for 8 hours.

Although it is interesting to speculate as to whether this shift in pattern was accidental or characteristic, and if characteristic why it occurred, the study provides no apparent basis for analysis.

It is interesting that there was continuous needle production at all photoperiodic treatments, Figure 3. This is in contrast to *Pinus sylvestris* L. which produced typical nodular growth at 8-, 12-, and 16-hour days but at 14-hour days gave the same continuous acicular growth pattern as Honduras pine (Downs and Borthwick, 1956). According to Downs and Piringer (1958) the number of fascicles on the juvenile stem is controlled by photoperiod.

Other growth habits included very little lateral branching, chlorosis (possibly attributable to excessive watering), occasional formation of terminal buds after thirty weeks, no lateral buds, and frequent curled, unelongated fascicles which did not always rupture the fascicular sheaths.

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double-spaced typewritten pages, although an occasional longer article of special interest may be acceptable. Articles should be submitted in the author's native tongue, and should include title or position of the author as well as a brief summary of the material. Manuscripts should be typewritten, double spaced, on one side of the page only, on 8½ x 11 inch white bond paper.

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Par les pages de cette revue les personnes qui travaillent aux tropiques peuvent etre informées sur les problemes specifiques des forets tropicales et sur les travaux effectués pour realiser une ameilloration technique par l'aménagement et l'usage des resources forestiéres. Cette revue pourvoit aussi un moyen de destribuer l'information et les resultats obtenus par le programme experemental du Institut de Foresterie Tropique de Puerto Rico; en plus cette revue offre ses pages a les autres travailleurs forestiers des pays tropicaux pour qu'ils purssent publier les resultats de leur travaux.

Cette revue accepte volontiers des contributions ne depassant pas 20 pages dactilografiées a double espace, cependant que certains travaux du intéret spécial plus long purvent etre acceptés. Les contributions doivent etre ecrites dans la langue maternelle de l'auteur et doivent bien preciser son titre et sa position professionnelle, l'appert doct etre accompagné d'un résumé de l'étude. Les manuscripts doivent etre dactilografiées en double espace su du paper 8½ por 11 pouces.

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Caribbean Forester

The Last Issue

With this issue the CARIBBEAN FORESTER terminates its appearance as a semi-annual forestry journal of the Institute of Tropical Forestry. The journal is being discontinued because of policy revision by the government of the United States. Henceforth the results of research at the Institute, like those of other Forest Service Research Units, will be published in a series of Research Papers and Notes which will be sent under the same terms to all who maintain active status on the same mailing list which has guided distribution of the Caribbean Forester.

The discontinuation of the Caribbean Forester does not signify any reduced interest at the Institute in the forest problems of Latin America. Research here will continue to deal with problems which are of regional importance. Our findings will continue to be distributed throughout the region.

An international technical journal which will serve the same purpose as the Caribbean Forester is planned for the near future by the Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica. Our mailing list has been sent for their use, in order to assure continued service to you all. We refer authors to that Institute for the future.

The publication of a technical journal, even one as modest as this, involves much work, editorial and otherwise. We have recognized also certain benefits of this responsibility, particularly direct access to reports on new work and firsthand communication with leading foresters throughout the American tropics.

In the 24 years that the Caribbean Forester has appeared, a total of 524 technical articles and notes have been published within it. Of these 210 were contributions from the Forest Service. These have come from or have referred to 45 different countries, and have concerned almost every phase of forestry.

Esta Ultima Edición

Con esta edición el CARIBBEAN FORESTER desaparece como una revista forestal semianual del Instituto de Dasonomía Tropical. La desaparición de la revista obedece a un cambio o revisión de política del gobierno de los Estados Unidos. De ahora en adelante los resultados obtenidos en los trabajos de investigación del Instituto, al igual que los de las demás unidades de investigación del Servicio Forestal, se publicarán valiéndose de una serie de apuntes y artículos que bajo los mismos términos se distribuirán a todas aquellas personas y entidades incluídas en la lista activa utilizada en el envío del Caribbean Forester.

La suspensión del Caribbean Forester no significa que el Instituto haya perdido interés en los problemas forestales de la América Latina. Nuestras investigaciones seguirán ocupándose de los problemas que tengan importancia regional. Seguiremos diseminando nuestros descubrimientos a través de la región.

El Instituto Interamericano de Ciencias Agrícolas de Turrialba, Costa Rica, se propone publicar en un futuro cercano una revista técnica internacional que servirá el mismo propósito del Caribbean Forester. Le hemos enviado a dicha institución copia de nuestro fichero de envíos para asegurarles un servicio continuo a todos ustedes. Para el futuro referimos los autores a ese Instituto.

La publicación de una revista técnica, aún una tan modesta como esta, requiere mucho trabajo, incluyendo la labor editorial y de otra clase. Reconocemos también haber derivado ciertos beneficios de esta responsabilidad, especialmente el acceso directo a los informes sobre trabajos nuevos y la comunicación directa con los principales dasónomos de los trópicos americanos.

En los 24 años en que el Caribbean Forester ha estado en circulación se han publicado un total de 524 apuntes y artículos técnicos de los cuales 210 fueron contribuídos por el Servicio Forestal. Estos artículos precedentes de o referentes a 45 países diferentes han tratado sobre casi todas las fases de la dasonomía.

The printing of this publication has been approved by Director of the Bureau of the Budget (June 26, 1958)
The Institute of Tropical Forestry is operated in cooperation with the University of Puerto Rico.

Caribbean Forester

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Forest Formations of Puerto Rico[1]

by

K. W. O. KUMME AND C. B. BRISCOE

SUMMARY

A map was constructed of Puerto Rico, showing the plant formations according to the Holdridge system of classification. This system is based on annual rainfall and biotemperature, and is relatively simple to apply.

RESUMEN

Se preparó un mapa de Puerto Rico mostrando las formaciones vegetales según el Sistema de Clasificación Holdridge. Este sistema se basa en la precipitación y biotemperatura anual. Su uso es relativamente sencillo.

"A forester faced with the practical problems of choosing what species to plant on a given site, or of selecting sites and species for the production of a particular type of timber, needs a detailed knowledge of the local climates and plant associations of his territory to supplement his general knowledge . . . " (Champion & Brasnett, 1959).

Of the many systems proposed for classifying climates and plant formations, one of the simplest is that of Holdridge (1947). Although there are minor considerations to facilitate usage, the system basically depends on only two variables: precipitation and biotemperature. The latter is simply the average of the temperatures which are above 0°C. In the true tropics, therefore, biotemperature is synonymous with average temperature.

An additional advantage of the Holdridge system is that it has been rather widely applied in the American tropics (Div. of Econ. Development, 1961; Holdridge, 1962, 1957; Tosi, 1960; Veillon, 1963; Tropical Forest Research Center, 1960). Thus a large body of information concerning counterpart areas is readily available if the same system is applied locally.

Finally in the Caribbean Area at least, there would appear to be no doubt that the Holdridge classification yields categories that are real and important.

For these reasons, Puerto Rico was mapped according to the Holdridge system of ecological formations.

PROCEDURE

BASIC DATA

As indicated above, the basic data necessary are average annual temperature and rainfall. Because this information was found to be less readily available than originally expected, some detail is provided on how it was obtained.

The Weather Bureau Climatological Data, Puerto Rico and Virgin Islands, 1961, yielded 26 stations for which the annual means and deviations from the long-term means were listed. The long-term means of these stations were calculated by algebraically subtracting the deviation from the annual mean.

Each previous year's summary was then searched for stations no longer active, and the same subtraction was applied to those found. Carrying this procedure back to 1900 yielded 21 additional stations, a total of 47.

The records, both published and unpublished, were then checked for stations for

1/ Begun as a special report for the 1963 Syracuse Forestry Summer Course, conducted by New York State University College of Forestry at Syracuse, in cooperation with the U. S. Forest Service Institute of Tropical Forestry.

which no long-term mean was ever calculated. For all such stations, annual values were listed and means computed. Because temperature is so uniform from year to year, a mean based on only a single year was accepted. Precipitation records were not used unless a minimum of four year's records were available. In all cases without long-term means, the actual basis was recorded to improve interpretation of conflicting values on the final map.

By these means, a total of 128 stations were assembled with average temperature, average rainfall, or both, Table 1.

MAPPING ISOMETRIC LINES

Each station was then plotted on a topographic map of the island, scale 1:120,000.

The appropriate isotherms were then constructed. As may be seen from the World Plant Formation Chart, Figure 1, the critical isotherm in Puerto Rico is that for 24°C. Additional adjacent isotherms were also drawn, as listed in Table 2.

These were based on the station data to the extent available, and modified by the adiabatic cooling constant. In general, differences between stations followed the adiabatic

Table 1.—*Weather stations, with annual means and elevations*

Station	Temperature	Rainfall	Length of Record[1]	Elevation
	°C	Mm.	Years	Meters
Aceituna		1978		663
Adjuntas	22.5	2129		457
Aguadilla	26.3		2	
Aguirre	26.2	1073		15
Aguirre Research Sta.	26.2	1193	6	15
Aibonito	21.9	1526		701
Alto de la Bandera	21.7	2379	3	793
Añasco	24.9	2152	7	8
Arecibo 2ESE	25.3	1469		5
Bacupey	24.0	1947	4,5	152
Barceloneta	25.6	1499		23
Barranquitas	21.7	1506		549
Bayamón	24.7	1196		23
Bayamón Hato Tejas	24.4	2091	7	55
Borinquen Field U.S.A.	24 7	1141	8	68
Cabo Rojo	25.6	1648		76
Caguas 2ENE	24.9	1646		76
Calero Camp	25.3	1453		75
Cambalache Expt. Forest	25.2	1433		30
Canóvanas 2 North	25.6	1946		9
Camuy	25 0	1308	7	
Caonillas Utuado	23.5	1951		259
Caonilla Villalba	22.0	1518		183
Carite Camp Tunnel	22.4	2084		610
Carite Plant I	24 5	1972		293
Cataño	25.6	1980		6

Station	Temperature	Rainfall	Length of Record[1]	Elevation
	°C	Mm.	Years	Meters
Cayey 1NW	22.8	1485		43
Central Aguirre	25.7	1167		6
Central San Francisco	25.2	839		9
Central Service Farm	24.5	2239		70
Cepero (Trujillo Alto)	24 9	1954	6	
Cidra 3E	22.7	1931		427
Coamo Dam	25.0	940		50
Coloso	25.1	2079		15
Comerío Falls Plant II	24.7	1914		113
Corozal 4W	24.4	1999		122
Cubuy	23.0	2848		390
Dorado 4W	25.2	1641		8
Dos Bocas	25.2	1974		61
El Verde	24.5	3263		183
Ensenada	24 9	773		8
Espíritu Santo	22.0	2376		518
Fajardo	26.3	1651		12
Garzas Dam	20.7	2307		758
Guajataca Dam	24.0	1982		200
Guánica Centrale	25.0	861		15
Guayabal Reservoir	25.8	1337		82
Guayama	26.8	1399		59
Guineo Reservoir	19 3	2746		915
Gurabo	24.7	1718		76
Gurabo Sub-station	24 7	1729	3,5	76
Hacienda Amistad	25.6	1302	1	
Hacienda Perla (A)	24 9	3335		
Humacao 1SW	25.2	2165		30
Inabón Falls	23.2	2919	6	
Indiera Baja	20.5	1711	7	854
Isabela 4 SW	25.3	1438		128
Isolina	23.6	2487		427
Jájome Alto	21.0	1928		
Jayuya	23.0	1968		427
Jiménez	25 2	2963		40
Josefa (Central Aguirre)	26.5	1289		8
Juana Díaz Camp	26.0	1149		61
Juncos 1E	24.8	1613		82
La Carmelita	22 8	2481	3,6	470
La Fé	26.0	2531		46
La Florida	25.4	2545		24
Lajas	24.6	1113		30
La Mina (El Yunque)	20 8	4630	3,7	762

Station	Temperature	Rainfall	Length of Record[1]	Elevation
	°C	Mm.	Years	Meters
Lares	23.8	2458		366
Las Marías	23.3	2625	5	305
Los Camos	25.0	1625		24
Losey Field	25.9		3	7
Luquillo	25.6	3499	7	
Mameyes (Utuado)	23.8	1887	6,8	305
Manati	25.1	1648		76
Maricao	21.8	2668	8	457
Maricao Fish Hatchery		2732	7	457
Marveña	25.9		2	351
Matrullas Dam	20.2	2210		762
Maunabo	26.6	1950		15
Mayaguez	25.2	2022		24
Mayaguez Airport		1964	4	6
Melanía Dam	26.8	993		43
Moro Camp	25.3	1553		125
Morovis	23.5	1802	5	229
Naguabo	25.9	2406		30
Orocovis (Barros)	22.6	1876	2,5	
Paraiso	25.5	2320		46
Patillas Dam	25.0	1688		73
Peñuelas (Salto Garcas)	23.0	2072		351
Ponce	26.0	915		12
Potala (Juana Díaz)		863		15
Puerto Real	26.2	1447		5
Ponce Mercedita (AP)	25.8	999	4	7
Quebradillas	24.9	1400		113
Ramey Air Force Base	25.3	1177		69
Rincon (2NNW)	24.5	1656	4	91
Río Blanco I	25.4	2792		40
Río Blanco II	22.8	3855		439
Río Cañas	26.0	1008		58
Río Grande El Verde	25.0	2840	4	107
Río Grande Valley	23 0	3242		399
Río Jueyes	25 2	988		43
Río Piedras	24.9	1892		30
Río Piedras Exp. Farm	24.9	1892		15
Roosevelt Roads	26.5	1718	4	21
Sabater		948		21
Saint Just	24.9	2011		30
San Cristóbal	25.9	2310		30
San Germán	25.3	1691		101
San Juan WB City	25.6	1537		14

Station	Temperature	Rainfall	Length of Record[1]	Elevation
	°C	Mm.	Years	Meters
San Juan WB Airport	25.4	1767		5
San Lorenzo Espino	22.7	3049		387
San Salvador	22.7	1832		457
San Sebastián	24.6	2390		69
Santa Isabel	25.4	857		8
Santa Rita	24.7	819		53
Souco	25.6		1	
Toa Alta (Los Cocos)		2173	5	
Toa Alta (Mucarabones)	24.5	2180	7	
Toa Baja Constancia	24.7	1706		15
Toro Negro Dam	20.2	2525	3	686
Tract 47	22.2	3583		480
Utuado	24 6	1879		131
Villalba	25.0	1850		158
Yabucoa 1NE	25.2	2113		30
Yauco	25.2	939	7	8
Yaurel		1620		40

1/ Number of years is listed only for short records.

Table 2.—*Boundary values between forest formations, modified.*

Temperature (centigrade)	Precipitation (millimeters)			
	Very Dry versus Dry	Dry versus Moist	Moist versus Wet	Wet versus Rain
		Subtropical		
21		1100	2225	4425
22		1175	2400	4650
23		1300	2600	5100
		Tropical		
24	700	1400	2800	5600
25	775	1525	3100	
26	840	1650	3350	
27	890	1775	3550	

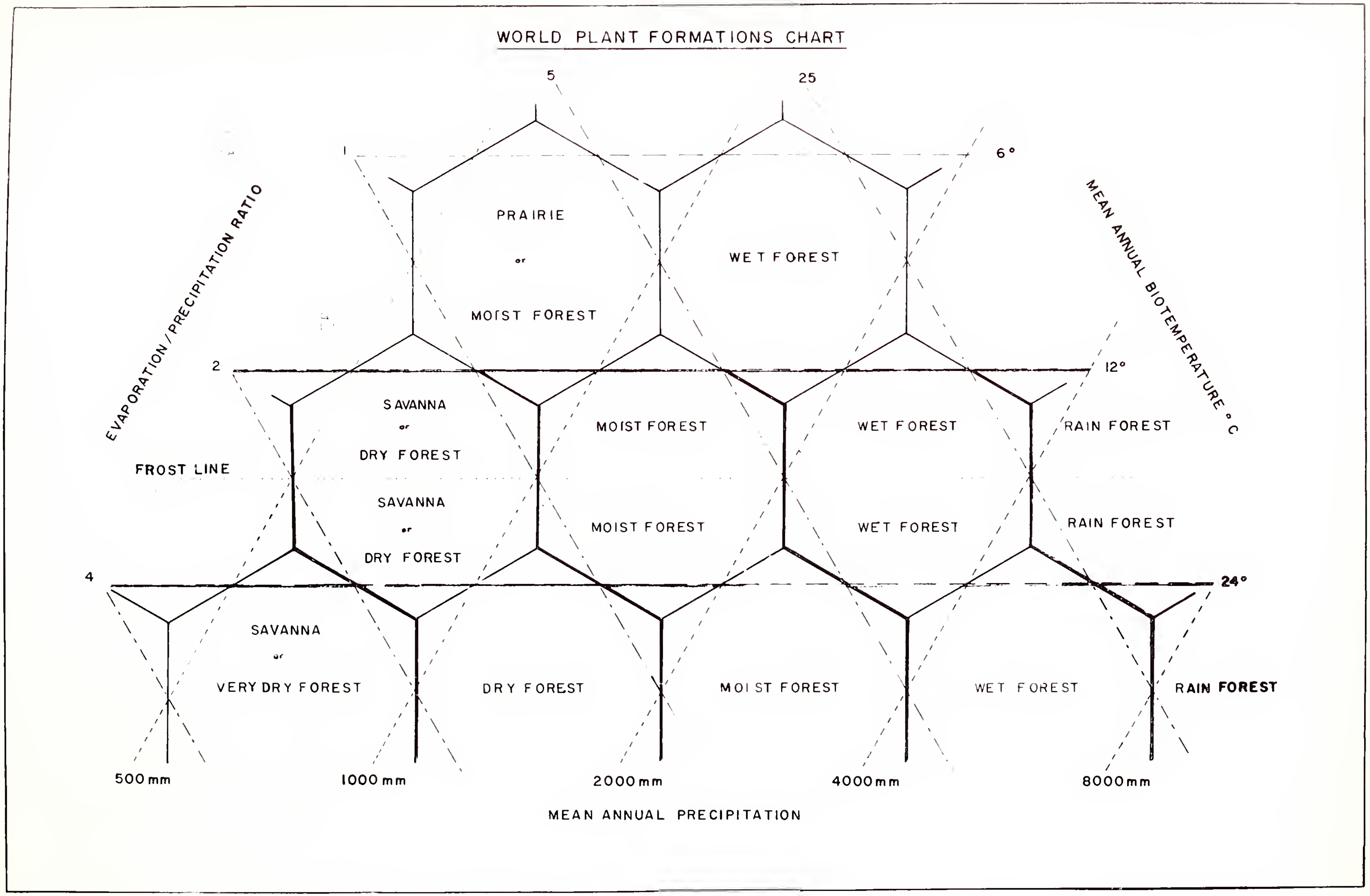

Figure 1. Holdridge's Plant Formation Classification Chart, pertinent portion enlarged.
Ampliación de la porción pertinente del Cuadro de Clasificación de Formaciones Vegetales de Holdridge.

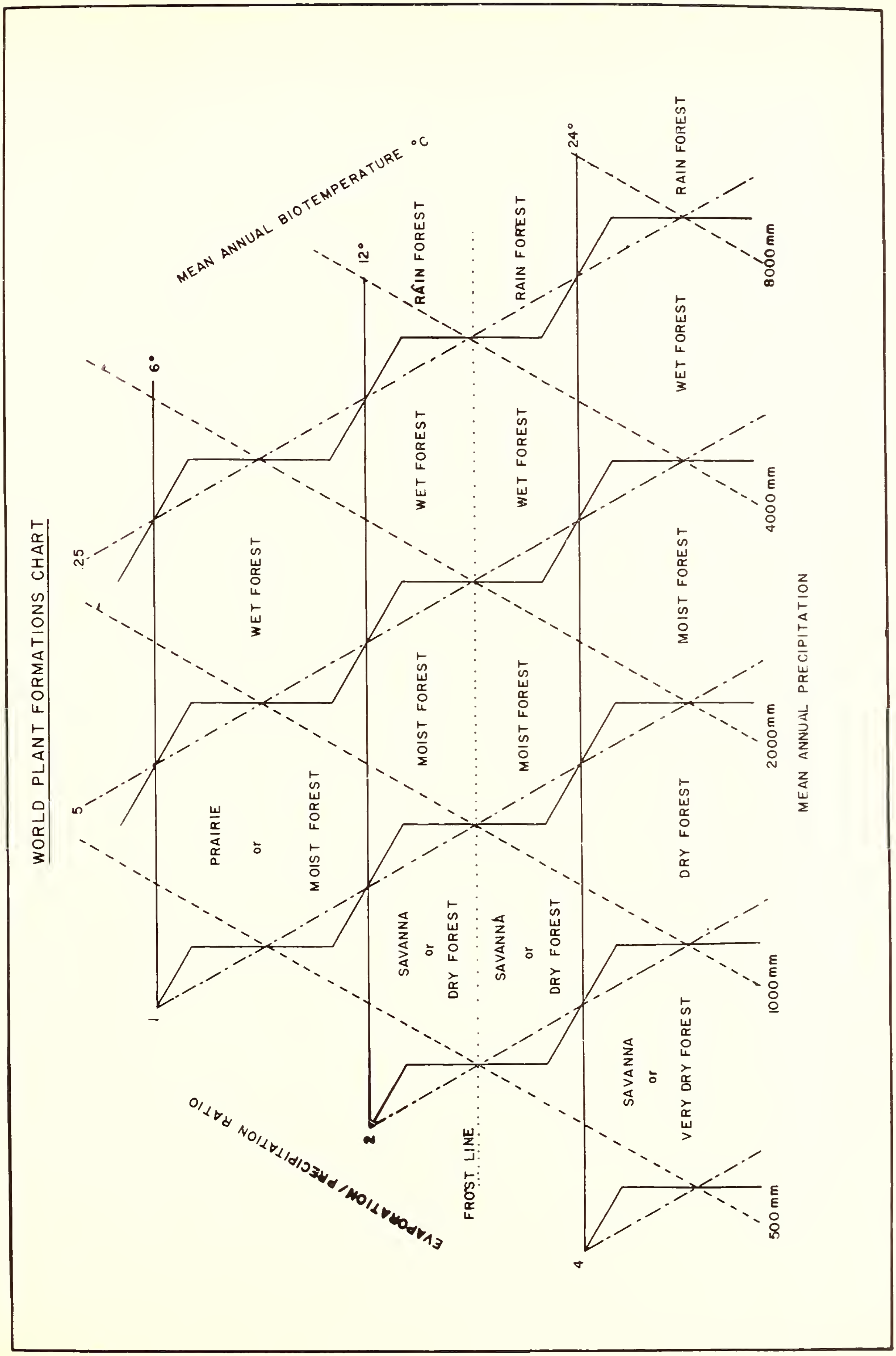

Figure 2. Modification of Holdridge's Plant Formation Chart.
Modificación del Cuadro de Formaciones Vegetales de Holdridge.

constant almost perfectly. Some exceptions occurred, however.

For example, the mean annual temperature for Aibonito is 21.9° and for Barranquitas is 21.7°C, but Barranquitas is nearly 150 meters lower. This apparent anomaly is probably because Barranquitas lies on the floor of a steep valley; it therefore receives fewer hours of sunshine than would a site on a level plain, besides receiving cold air drainage from the surrounding slopes.

In such cases, a certain amount of personal judgement was necessary in locating the appropriate isotherms.

Isohyets were located in the same general manner, for the values listed in Table 2, plus 500, 1000, 2000, and 4000 millimeters. Although rainfall exceeds 8000 mm. some years at some stations, there is no existing station at which the average annual rainfall exceeds that amount.

PLANT FORMATION DESIGNATION

The classification chart prepared by Holdridge, a portion of which is reproduced in Figure 1, consisted of a network of hexagons. Each junction point where three hexagons join is enclosed within an equilateral triangle formed by the evaporation/precipitation ratio line, the mean annual precipitation line, and the horizontal temperature line. The enclosed area is assumed to be an area of transition in which the actual formation may vary with edaphic, topographic, or other factors. Assignment of a particular location to a specific formation, therefore, requires on-the-ground observation, because even the laborious calculation and plotting of all relevant isotherms and isohyets cannot compensate for the basic fact that other factors may be decisive in the neighborhood of dividing lines.

Therefore, Holdridge's chart was modified, Figure 2. The transitional areas were then categorized according to the values listed in Table 2.

MAPPING PLANT FORMATIONS

Considering the combination of temperature with precipitation, then, a map of the plant formations in Puerto Rico was prepared, Figure 3.

Certain weaknesses of the map are not apparent. The Lajas Valley, near the southwestern corner of the island, has very few stations; neither is there any appreciable amount of undisturbed native vegetation. Consequently the boundary between the Tropical Dry and Tropical Very Dry formations in that area is more of an educated guess than a calculation.

The limestone hill areas, especially in the northwestern part of the island, are also very deficient in weather recording stations. Interpolation between existing station, as well as topographic maps, helped compensate for the lack of stations, but formation boundaries in the limestone hill regions should definitely be considered as approximations only.

Finally, the small area of Subtropical Dry formation which includes the Guánica Insular Forest and in which there is no weather station was separated from the surrounding Tropical Dry only on the basis of elevation. There are certainly grounds for suspecting that the slightly higher elevation of these low hills is not adequate, in fact, to support a change.

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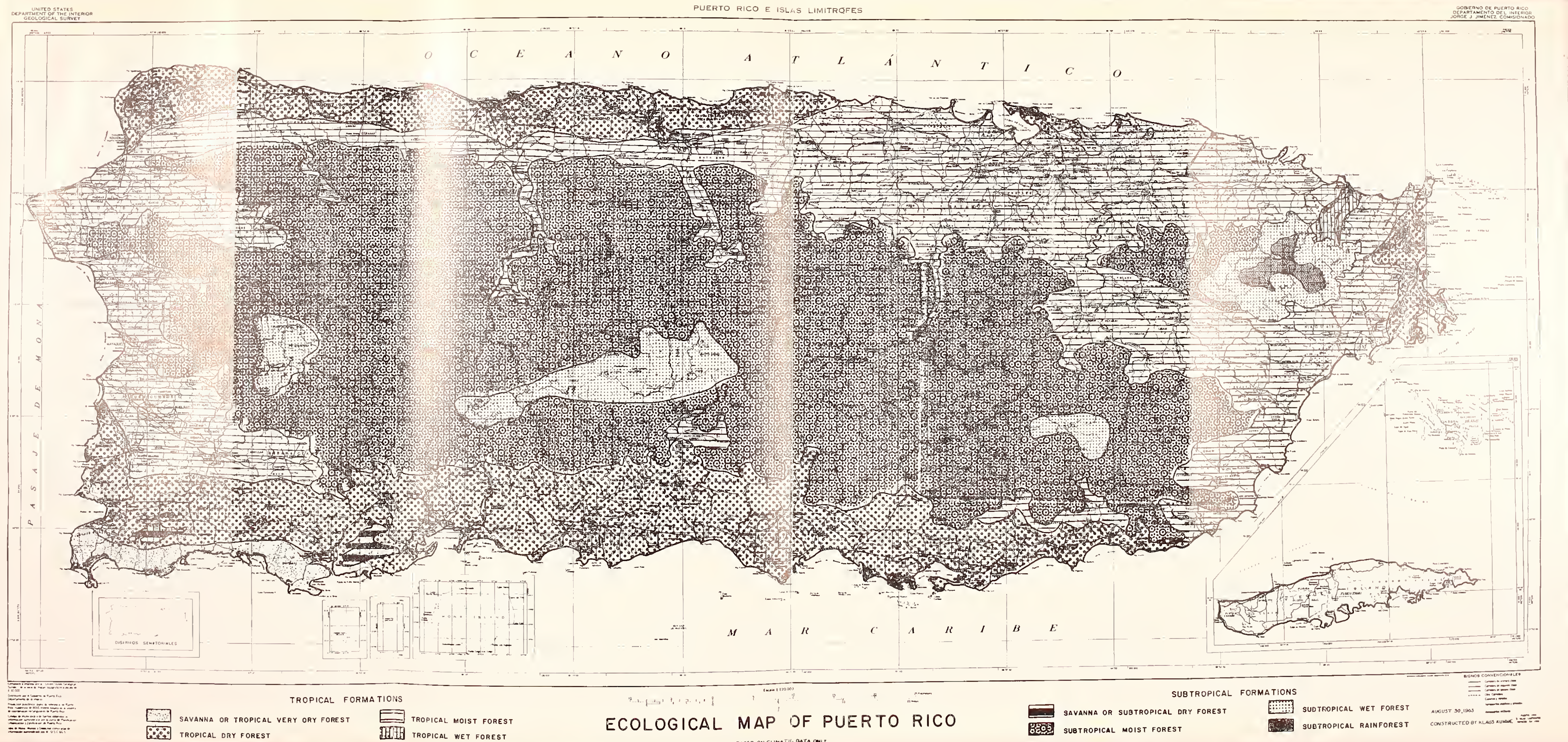

Figure 2. Plant formations of Puerto Rico, as derived from the modified Holdridge Classification. Formaciones vegetales de Puerto Rico, según la Clasificación de Holdridge modificada.

Variation of Specific Gravity in Plantation-Grown Trees of Bigleaf Mahogany

by

C. B. Briscoe,

J. B. Harris,

and D. Wyckoff

S U M M A R Y

As a prelude to tree improvement work in the genus **Swietenia**, a study was made of specific gravity variation within the bole of six plantation-grown trees of bigleaf mahogany.

Variation was appreciable, from 0.36 to 0.65, and several patterns were determined. Specific gravity of the tree increased with growth rate, as expressed in diameter at breast height, but not with relative length of radius at a given height in a particular tree. It increased outward from the pith; but it was high at the base, dropped markedly to a minimum at eight feet, then increased to near the base of the crown. There was no clear correlation with direction, but in these trees the wood at heights of 22 and 29 feet is heavier along the west radius.

Tree specific gravity can be estimated from specific gravity at the pith at 1-foot height, $r = 0.618$, or from core specific gravity and growth, as expressed by diameter breast high and merchantable height, $r = 0.987$.

R E S U M E N

Como un preludio del trabajo para el mejoramiento de árboles del género **Swietenia**, se hizo un estudio de la variación del peso específico dentro de los troncos de seis árboles de caoba de hoja grande crecidos en plantación.

La variación fué apreciable, de 0.36 a 0.65 y se determinaron varias tendencias. El peso específico del árbol aumentó con la rapidez de crecimiento en el diámetro a la altura del pecho, pero no con la longitud relativa del radio a una altura dada de un árbol en particular. El aumento fué desde la médula hacia afuera; pero fué mayor en la base, disminuyó notablemente al mínimo a los 8 pies de altura y luego aumentó hasta cerca de la base de la copa. No se registró una correlación clara con la dirección, pero en estos árboles la madera a una altura de 22 y de 29 pies es más pesada en el radio oeste.

El peso específico de un árbol puede estimarse del peso específico en la médula a un pie de altura, $r = 0.618$, o del peso específico del centro y el crecimiento, según lo demuestra el diámetro a la altura del pecho y la altura comerciable, $r = 0.987$.

"Specific gravity of wood is of practical interest because it is the best single criterion of strength" (Desch 1938, page 58). Continued study has supported this basic premise (Kraemer 1956, Nicholls & Dadswell 1960, Radcliffe 1953).

Tree improvement, particularly, requires an estimation of the quality of standing trees, and the present study was primarily to provide background information for a proposed tree improvement program[1] for bigleaf mahogany (*Swietenia macrophylla* King).

Knowledge of the entire merchantable portion of the stem is necessary, however,

1/ Barres, H. 1963. Mahogany provenance study plan. U.S. Forest Service, Institute of Tropical Forestry, Rio Piedras, Puerto Rico.

and the objectives of this study were (1) to determine whether specific gravity varies within a tree and, if so, (2) to study the pattern of variation.

PREVIOUS WORK

Gymnosperms have now been studied fairly extensively (Spurr & Hsiung 1954, list 87 references) and variation has been found to occur. The pattern is fairly well accepted as being essentially that described by Chevandier in 1848.

(1) Specific gravity increases with age, fairly rapidly at first and later very slowly if at all. In some species, at least, there are reports (Desch 1932, Sekhar & Negi 1961, Spurr & Hsiung 1954) that wood produced by overmature trees is lighter than that produced earlier. This pattern is the same at any given height in a tree. In spruce, at least, this normal pattern is modified in that the specific gravity next to the pith is relatively high drops off rapidly, then begins the normal increase with age (Bryan & Pearson 1955, Nylinder 1953).

(2) For wood laid down during a given year, specific gravity decreases with height. This pattern, also, is modified in spruce and similar species with indistinct summerwood and pronounced taper (Nylinder 1953, Spurr & Hsiung 1954). Specific gravity may even increase with height.

(3) There is no regular relationship of specific gravity with ring width. This point has been the subject of a great deal of controversy, chiefly because of the confounding of ring width with tree age and height in tree, see above, and with precentage of latewood, see below.

(4) Not mentioned by Chevandier, but extensively documented in this century (Larson 1957, Nylinder 1953) is that specific gravity varies with percentage of latewood, at least in those species with distinct latewood and earlywood (Spurr & Hsiung 1954).

Ring-porous hardwoods, particularly species of *Quercus* and *Fraxinus* have also been studied, though less extensively. For these species, the proportion of latewood apparently far outweighs other considerations (Bethel 1943). Therefore, specific gravity tends to decrease with age and from the crown toward the tree stump, just as percentage latewood tends to decrease.

Diffuse porous hardwoods, a group which includes most tropical hardwoods, have been studied much less, and, despite McLintock's (1957, page 2) somewhat optimistic statement "In the case of hardwoods —both ring porous and diffuse porous— the facts are well established . . . ", the results are apparently not consistent, even within a species.

(1) Specific gravity increased with age (Aung 1962; Stauffer 1892; Curro 1957, 1960; Anonymous 1948; Murthy 1959), or it increased for some trees and decreased for others (Lenz 1954), or —like spruce— it decreased at first then increased (Grossler 1943), or varied with age in the lower bole only (Gohre & Gotze 1956), or was simply irregular (Anderson & Moltesen 1955).

(2) Specific gravity decreased with height (Burger 1940, Tamolang & Balcita 1957, Stauffer 1892), or increased briefly then stabilized (Grossler 1943), or decreased upward a few meters then increased (Gohre & Gotze 1956), increased with height (Burger 1940, Curro 1957, Lenz 1954) in single rings as well as the entire disc (Curro 1960) or did not vary with height (Anonymous 1948, Greenhill & Dadswell 1940).

(3) Rapid growth may be associated with decreased specific gravity (Susmel 1953), increased specific gravity (Grossler 1943), no relation (Anonymous 1948, Lenz 1954, Gohre & Gotz 1956, Seaman 1926), or with increased specific gravity in some species and decreased specific gravity in others (Ghosh et al. 1958).

Since there is no clear distinction between early and late wood, their differences have not been studied.

Site, however, has often been thought to exert influence, certainly as it influences growth. In addition, Hartig (1897) felt that good sites produce fast growth of high density, as opposed to wide spacing yielding fast growth of low density. The results reported (Susmel 1953) fail to support this distinction. Altho Murthy (1959) reported no specific gravity variation in stems of swamp-grown timber of a species in which specific gravity increased with age on other sites, most studies have failed to correlate specific gravity with site *per se*.

The reader who wishes to review thoroughly the pertinent literature should begin with "The Influence of Environment and Genetics on Pulpwood Quality" (Forest Biology Committee, TAPPI 1962); the preceding indicate that variation does occur, but the pattern is certainly not universal among diffuse porous species.

PROCEDURE[2]

Bigleaf mahogany is an exotic in Puerto Rico, so plantation-grown trees are the only ones available. To reduce extraneous variation, trees from only a single plantation were used, with one exception. A preliminary analysis failed to show the single tree different from the other five, so the data were combined.

Before felling, each tree was marked with the four cardinal directions and a reference height.

Immediately after felling the merchantable bole was marked off in 7-foot sections from the butt, which was normally cut one foot above ground level. Cardinal directions were marked at each point previously designated for cross-cutting, then a disc 1-2 inches thick was cut out, labelled, and stored in a polyethylene bag to reduce moisture loss.

In the laboratory, each disc was marked with a 1-inch strip, from east to west and another from north to south, intersecting at the pith. Each strip was then marked into 1-inch lengths, labelled, then cut out with a small band saw.

RESULTS

The green volume and oven-dry weight were then determined and the specific gravity calculated for each block, a total of 429 blocks from six trees. Individual block specific gravity varied from 0.36 to 0.65. Weighted[3] specific gravity of a radial strip varied from 0.38 to 0.61; disc specific gravity varied from a low of 0.40 to a high of 0.58.

Clearly there is variation; the problem is to determine the pattern.

TREE SPECIFIC GRAVITY

The question of most interest was whether tree specific gravity could be estimated from a small sample. Affirmative results have been obtained with pine (Harris 1963, Zobel & Rhodes 1956), and for other characteristics with poplar (Bialobok 1963), fir (Stage 1963), and spruce (Ruden 1963), among others (Zobel 1961). The small sample of greatest utility in a program of tree improvement would be the first wood laid down. Therefore, a regression was run of specific gravity of the tree on that of the core at 1 foot height. That is, an equation $Y = a + bx$ was solved, using the weighted specific gravity of the tree as "y" and the specific gravity of the 1-inch block from the center of the disc cut at 1-foot height as "x."

2/ The field procedure and preliminary analyses were conducted as part of a special study for the 1962 Syracuse Forestry Summer Course, conducted by New York State University College of Forestry at Syracuse, in cooperation with the U.S. Forest Service Institute of Tropical Forestry.

3/ Because a cube of fixed cross-sectional area represents a portion of the total which diminishes with distance from the pith, variable weighting must be used to determine radius or disc specific gravity. Area represented by a sample is approximately equal to Pi times the square of the radial distance to its outer limit, minus Pi times the square of the radial distance to its inner limit. This yields areas of 0.785, 6.284, 12.566, 18.850, and 25.132 square inches for 1-inch squares with the radial length to the outer edge of 0.5, 1.5, 2.5, 3.5, and 4.5 inches, respectively. Dividing through by 0.785 gives relative weights of 1, 8, 16, 24, 32, 40, 48, 56, etc.

In other words, the ring of wood 5.6 to 6.5 inches from the pith has 48 times as much cross-sectional area as a ring from 0.1 to 0.5 inch from the pith.

The mean specific gravity of a radial strip, therefore, equals 1 x specific gravity at 0-0.5 inch from the pith, plus 8 x specific gravity at 0.6-1.5 inches, plus 16 x specific gravity at 1.6-2.5 inches . . . , plus 48 x specific gravity at 5.6-6.5 inches, the sum of the products being divided by the sum of the weightings.

The relationship was encouraging, a correlation coefficient of 0.618, but was not significant for so few trees.

When the equation was expanded to include growth rate (as expressed by dbh), the correlation was raised to significance. Further expansion of the equation to include merchantable height raised the combined correlation coefficient to 0.987. Best estimate of the tree specific gravity was:

Tree Specific Gravity = 0.1834 + 0.4790 Core Specific Gravity at 1 foot + 0.01649 dbh — 0.01124 No. 7-foot Bolts.

GROWTH RATE

Since the importance of growth rate was so clearly indicated in the preceding analysis, two further tests were made.

The first was to determine whether the specific gravity of the wood most recently laid down was also correlated with growth rate. Considering only the outermost 1-inch blocks at the 1-foot and 8-foot levels, their specific gravity had a correlation coefficient of 0.91 for dbh alone, and 0.94 for dbh and height in combination.

The next test was to determine whether the specific gravity of a particular radius, as compared to the entire cross-section of the stem, was related to the length of radius, as compared to the average radius for that cross-section. If

$$\text{"y"} = \frac{\text{Radius Specific Gravity}}{\text{Disc Specific Gravity}}$$

$$\text{and "x"} = \frac{\text{Radius Length}}{\text{Disc Average Radius}}$$

is y correlated with x, in the equation $Y = a + bx$? For the 136 discs available for analysis, there was virtually no correlation whatever.

The two preceding analyses indicate then, that (a) tree specific gravity increases with tree growth rate as expressed by dbh and number of bolts, but (b) specific gravity along a radius within a particular cross-sectional disc of the bole is not related to the relative growth rate along that radius.

That is, specific gravity increased with increasing tree growth rate, but did not vary with variations in growth rate along different radii at the same level in the same tree.

CORE VERSUS ADJACENT BLOCKS

As noted above, some reports (Grossler 1943, Nylinder 1953, Sekhar & Negi 1961) have indicated that the wood immediately surrounding the pith is relatively heavy, and that the very light "juvenile" wood does not include the actual tree center.

Comparison indicated that in these 34 mahogany discs the core is highly significantly lighter than the adjoining blocks. Practically speaking, however, the difference of 2 percent is of little consequence.

VARIATION ABOUT THE BOLE

To determine whether specific gravity varies around the bole at a given level, the four radial values obtained were placed in descending order. The results are exemplified in Table 1.

Table 1. *Mean specific gravity at specified heights of peripheral blocks, all trees combined. For each tree the values were placed in order of magnitude.*

	Specific Gravity				
Height	Highest	Second Highest	Third Highest	Lowest	Mean
Feet					
1	.533	.523	.517	.498	.518
8	.457	.443	.438	.427	.441
15	.470	.448	.438	.428	.446
22	.496	.474	.460	.448	.470
Average	.489	.472	.463	.450	

The apparent differences are highly significant, but this could be random variation. There have been many reports that specific gravity differs on the north and south sides of the stem (Nylinder 1953).

Table 2. *Mean specific gravity of mahogany, by height above ground and cardinal direction. Individual blocks were weighted by distance from the pith; each tree value was given unit weight.*

Height above ground	Specific Gravity by Cardinal Direction				Entire Disc	No. Trees
	North	South	East	West		
Feet						
1	.52	.51	.51	.50	.51	6
8	.44	.44	.43	.44	.44	6
15	.45	.44	.45	.45	.45	5
22	.47	.47	.46	.50	.48	5
29	.49	.49	.47	.51	.49	5
36	.52	.51	.52	.55	.53	3
43	.58	.57	.56	.55	.56	2
50	.52	.52	54	.54	.53	2
Total Stem	.49	.48	.48	.49	.486	

Inspection of Table 2 shows that for the stem as a whole no significant differences are to be found between directions. There are indications that two borings give a more accurate estimate than one, and that borings 180° apart may give a more accurate estimate than those 90° apart.

The data presented by Lenz (1954) showed this same overall uniformity among radii, but showed rather clear differences at some point up the bole. The same indication is found in Table 2; in this case, the west radius appears heaviest in the neighborhood of 25 feet.

VARIATION ALONG THE BOLE

Both tables 1 and 2 clearly show that specific gravity is high at the base, drops to a minimum at eight feet (of the heights tested), then climbs steadily to near the base of the crown.

VARIATION ALONG THE RADIUS

The variation in length between radii prevents a clear tabular presentation of the variation of specific gravity outward from the pith.

The combined indications mentioned in the three preceding sections were tested by multiple regression analyses[4]/.

Specific gravity of the west radius is significantly heavier, at heights of 22 and 29 feet. It must be emphasized that an analysis such as this proves only that a difference the authors thought they saw in a particular set of data actually exists. Only further testing can indicate whether the relationship found in these trees is part of a general pattern.

Specific gravity varied significantly with height in bole. Each tree showed the same

4/ The authors are indebted to the Computing Laboratory, Oxford University for machine solution of a number of the equations.

trend, and there seems little room for doubt that the sample represents a real pattern. Variation is much more strongly correlated with absolute height than with relative height; that is, height in feet was a better expression than height as a percentage of merchantable height.

Specific gravity also increased significantly outward along a radius. Inches from the pith was a more useful expression than percentage of the total radius.

CONCLUSIONS

A study was made of the variation of specific gravity in the boles of six plantation-grown trees of bigleaf mahogany.

1. Tree specific gravity can be estimated from specific gravity at the core of a disc cut one foot above the ground line, r = 0.618.

2. A highly significant correlation was obtained of tree specific gravity with the combination of core-at-1-foot specific gravity plus dbh plus merchantable height, r = 0.987.

3. The specific gravity of the outer 1-inch of wood in the lower bole was correlated with the same three variables. The correlation coefficient was identical to three decimals 0.987, but there was relatively less correlation of the outer wood with core specific gravity and more with dbh.

4. The variation in specific gravity of radii at a given height of a particular tree was not related to their relative growth rates at that point.

5. The wood immediately surrounding the pith was the lightest, and specific gravity increased outward. Progression was erratic or altogether missing in some radii.

Specific gravity was high at the base, dropped to a minimum at eight feet, then increased upwards to near the base of the crown.

7. For the entire trees, specific gravity varied between radii, but not in a definite pattern.

8. At a height of 22 and 29 feet wood in these six trees averaged significantly heavier on the west radius.

9. Position along the radius removed more of the total variance when expressed in inches from the pith than when expressed as a percentage of the radius.

10. Height in feet removed more of the total variance than did height as a percentage of merchantable height.

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Rainfall Interception in a Tropical Forest[1]

by

ALBERT G. CLEGG

SUMMARY

Rainfall interception was studied in the Luquillo Mountains of Puerto Rico, for twelve individual rainfalls.

Interception in inches of rain varied directly with total rainfall and with crown density.

Percentage interception also varied directly with crown density —for a given amount of rain— but varied inversely and curvilinearly with amount of rain.

Interception did not vary between the two forest types considered, but was quite high in both.

RESUMEN

Durante doce aguaceros individuales se estudió la interceptación de la lluvia en la Sierra de Luquillo en Puerto Rico.

La interceptación por pulgadas de precipitación varió directamente con la lluvia total y con la densidad de las copas.

El porcentaje de interceptación también varió directamente con la densidad de las copas —para una cantidad específica de lluvia— pero varió inversamente y curvilineamente con la cantidad de lluvia.

No varió la interceptación entre los dos tipos de bosques bajo estudio, pero fué más bien alta en ambos.

In forests of the temperate regions, rainfall interception has received considerable study in past years, the data having a wide range of application in both hydrological and ecological studies. Recently the importance of this variable has been realized in tropical zones where high percentages of crown densities and high rates of precipitation often prevail, and where population pressures in tropical areas of recent years have incited new investigations into the water supply picture. Puerto Rico is an example of such an area.

This exploratory study was conducted in the Luquillo Mountains to determine the interception rate of rainfall in two sub tropical forest types, and to investigate methods and procedures applicable to tropical forest conditions.

PROCEDURE

LOCATION AND DESCRIPTIONS

The study was carried out from July 31 to August 16, 1962, in second growth forest of the Colorado and Tabonuco types, approximately 35 years old, at an elevation of 1700 feet. Average annual precipitation is about 130 inches, chiefly orographic rains of light to heavy intensities.

Twelve falls were recorded over the period, four of which were light intermittent rains covering a 24-hour period. These latter four were recorded as individual falls and grouped with the eight separate rains. Intensities of the individual showers varied from 0.11 to 0.90 inches. One fall of 2.90 inches was not incorporated into the data. Precipitation was recorded at 8:00 a.m. each day.

PLOT LAYOUT

Five plots, each four feet square and half a chain apart were set on each of two transects two chains apart (10 plots), in each of the two forest types. Ten control plots (zero crown density) of the same size were randomly placed in openings in the stands as near as possible to the transects.

CROWN DENSITY

Crown density was measured over each four-foot square plot, at the beginning and at

1/ Prepared as a special report for the 1962 Syracuse Forestry Summer Course, conducted by New York State University College of Forestry at Syracuse, in cooperation with the U. S. Forest Service Institute of Tropical Forestry.

the termination of the experiment; the average of the two readings was used in the analysis. Crown density, determined from a spherical densiometer is the average of four readings, one reading made while facing in each of the four cardinal directions while standing within the four-foot square area of each plot. Over the period of study, crown density measurements increased an average of six percent, varying from a loss of six percent on one plot to a gain of 15 percent on another; all but one increased. New flushes of leaves were seen emerging during the period of study. No leaf fall was noted.

PRECIPITATION MEASUREMENT

Precipitation was measured in No. 2 cans with spikes soldered to the bottom, randomly placed on each plot. The spikes held the gauges upright and prevented the rats and mongooses from carrying them away.

The gauges were not precisely calibrated, but it was found that one cubic centimeter of rain was lost for any amount that fell. Most of the loss was recovered from the can sides by swirling the can around before pouring the contents out. As the cans became older (in days), the sides became more adhesive to water. There was little or no loss by evaporation, especially from gauges under the crown canopy. The amount of water in the gauge was, therefore, recorded as the actual amount of rainfall or through fall.

One inch of water in the gauge was equal to 90 cubic centimeters. Accordingly, a table was prepared for converting cc. to hundredths of inches. The contents of each gauge was emptied into a graduated cylinder, and the amount recorded was later converted to inches.

Rainfall recorded for each plot was the average of the four gauges. Each gauge was returned to the plot after its water was measured, but not necessarily to the original position.

STEM FLOW

No attempt was made to measure stem flow, that part of the rain which finds its way to the soil by means of the tree stems or the stems of other plants. Much study has been done in temperate regions on this variable (1) (2) (3). Different investigators set stem flow at from less than one-tenth of one percent to as high as ten percent of the total rainfall, depending on the duration of the storm and the species studied. Considering the rainfall intensities and the mass of vegetation on the site, little stem flow seems probable. Even if allowances of

Rainfall	Stemflow
.3 - .6 inches	one percent of the total rain
.6 - .9 inches	two percent of the total rain
.9+ inches	three percent of the total rain

are assumed, the effect on the data is so small that analysis was made excluding the variable. Stemflow and evaporation during the storm presumably would be included in longer, more precisely programmed studies.

ANALYSIS OF DATA

As analysis of variance indicated that interception on the two forest types was not significantly different; the two sets of data were therefore combined, and a regression analysis made of combined results, Table 1.

Table 1.—*Summary of rainfall information all plots, all crown densities.*

Shower	Rainfall (Inches)	Interception (Inches)	Interception (Percent)
1	0.11	0.07	64
2	.90	.47	52
3	.71	.36	50
4	.29	.19	66
5	.22	.15	68
6	.83	.39	47
7	.50	.21	42
8	.31	.13	42
9	.22	.17	77
10	.33	.14	42
11	.68	.44	64
12	.22	.16	73
Average	.44	.23	57

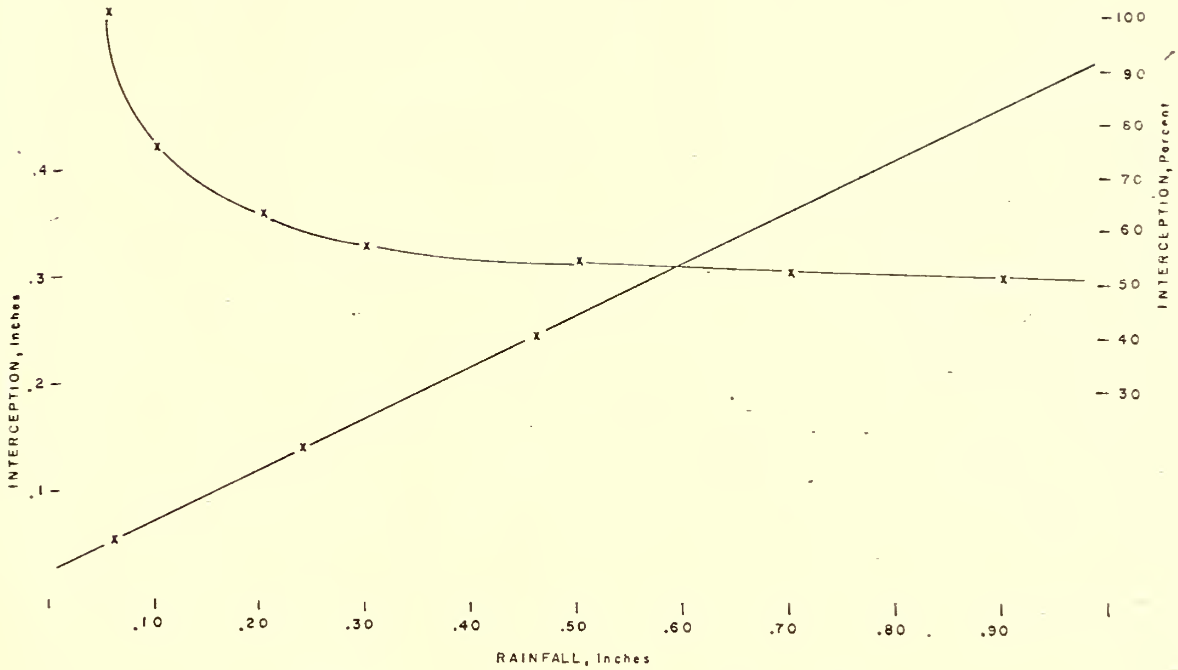


Figure 1. Interception as related to rainfall, all plots. Solid line is in inches ($Y = 0.479X + 0.029$, $r = 0.951$), and dash line is in percentage.
La intercepción en relación a la precipitación, todas las parcelas. La línea sólida representa las pulgadas, la línea interrumpida el porcentaje.

Inches of interception, for all crown classes combined was related to inches of rainfall, figure 1. The regression is estimated by a linear function of Interception = 0.479 Rainfall + 0.029, with a correlation coefficient of .951. Interception varied from 0.05 inch when rainfall was .05 inch, to 0.41 inch when rainfall was .80 inch. Fifty-four percent of the measured rainfall was intercepted.

If interception in inches is converted to percentage interception, a curvilinear expression results.

Interception was found to differ with crown density, figure 2. Only 23 percent of the total rainfall was intercepted by the 72-76 percent crown density class, but 57 percent was intercepted by the 80-86 percent density class. These results indicate that rather small variations in crown density account for large variations in interception rate. To obtain a more exact idea as to this rate, interception was directly related to crown density, figure 3.

Interception clearly increased with crown density. For each one percent increase in crown density from 72-87 percent, there was a 3 percent increase in interception rate. The regression is approximated by a linear function of $Y = 0.0143X - 0.944$, with a correlation coefficient of 0.928. If this relationship is maintained, all of a 0.44-inch is intercepted at a crown density of 97 percent.

DISCUSSION AND CONCLUSIONS

While the relationships between the several variables used here were found to be significant to highly significant, the reader must remember that the study is brief and exploratory, and in a field somewhat separated from previous studies, most of which pertain to temperate forest types (3). In the latter there is for all species, a period of maximum

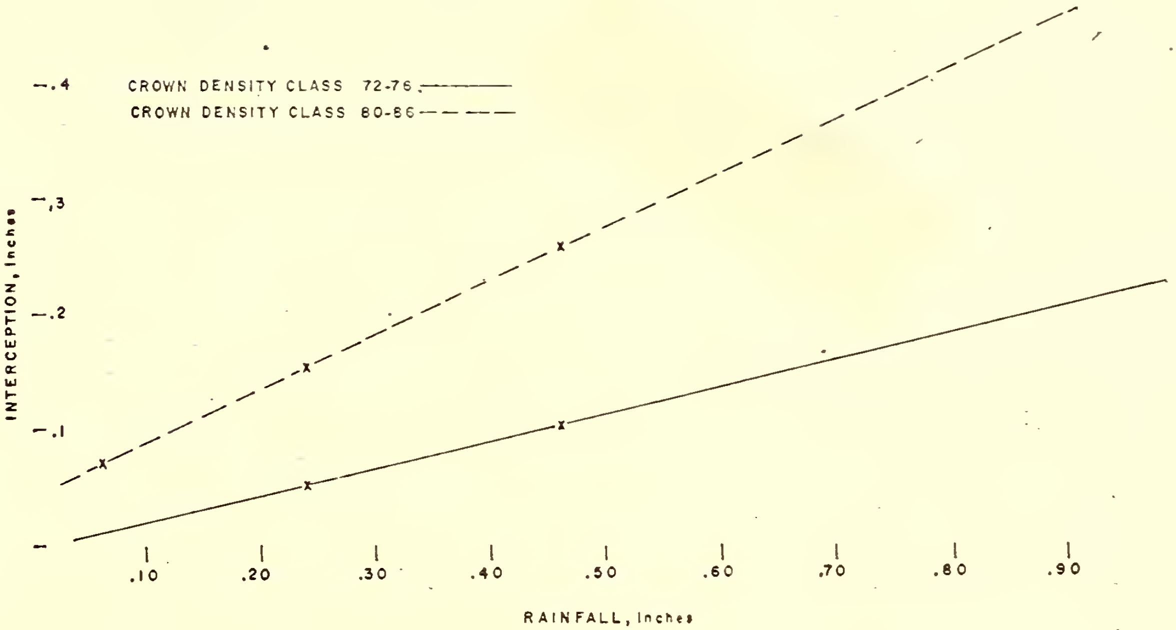
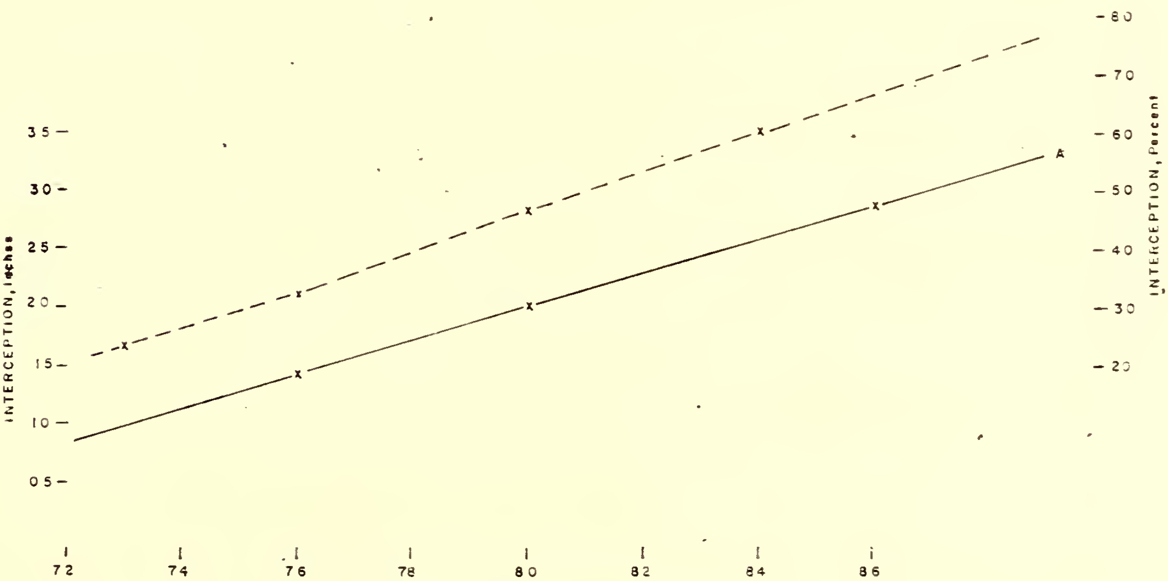


Figure 2. Differences in rainfall interception between crown density classes. Upper line is for density class 80-86 ($Y = 0.467 X + 0.045$, $r = 0.935$); lower line is for density class 72-76 ($Y = 0.268 X - 0.018$, $r = 0.808$).

Diferencias en la interceptación de la precipitación entre las clases de la densidad de las copas. Línea superior indica la clase de densidad 80-86; línea inferior indica la clase de densidad 72-76.



CROWN DENSITY, Percentage

Figure 3. Interception as related to crown density. Upper line percentage, lower line inches.

Interceptación en relación a la densidad de las copas. Línea superior indica el porcentaje, línea inferior las pulgadas.

crown density, and a period of minimum crown density. This makes for a minimum of study to determine periodic or annual interception. In a tropical climate on the other hand, there always exists a distinct crown density, yet this density appears to vary continuously and significantly, necessitating continuous precipitation and crown density measurements to bring about accurate determinations of annual interception rates. In any one period, new flushes of leaves on one species may or may not be compensated by leaf fall on another species and in that period, crown density may be in the range of 80-90 percent. Conversely a period of no leaf emergence may follow, accompanied by heavy leaf fall on many species. Over these periods, a different pattern of rainfall may develop, the data of which if collected and analysed, would result in regressions quite different from those presented here.

In figures 2 and 3 the 78 percent crown density class was omitted because interception in this class was found to be abnormally high. Since crown density class 78 was confined to two adjacent plots, it was assumed that some geographic or geologic feature was present here which caused the rains to be partially wafted over these plots to fall elsewhere in greater intensity. This point would require further investigation before a definite conclusion could be made. On the other hand, certain plots on occasion registered more throughfall than rainfall recorded on the check plots, which would indicate that either the water was channelled to the gauges or more rain actually fell over these plots than fell over the check plots. Future interception studies therefore should endeavor to improve the check plots, ideally by keeping them near the throughfall plot but above the tree crowns.

Direct observations indicated that stem flow is not significant for rainfall intensities of the range studied. Smooth barked, wide crowned trees did show some stem flow in heavier showers.

The almost daily and often several times daily rainfalls encountered would seem to necessitate the investigator associating himself closely and continuously with the site. He would thus be in a position to estimate the duration of showers, the condition of the foliage previous to a shower, and such other conditions and variables as may be essential to a more accurate analysis.

The 54 percent rate of interception is higher than exceptional cases found in temperate zones where, in California, Munns (4) found 31 percent interception in California scrub oak and Kittredge (3) found 37 percent interception in dense spruce and balsam fir in Maine. Pearson (5) found 40 percent interception in a stand of ponderosa pine at 7,520 feet elevation in Arizona much of which is ascribed to the high evaporating power of the air.

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Trends in Wood and Paper Imports into Puerto Rico[1]

by

HAROLD W. WISDOM

SUMMARY

Wood and paper make up about 5 percent of the total commodity imports into Puerto Rico. In 1960 their value came to $46 million, with the United States supplying 72 percent of this total.

Trends in wood and paper imports over the last two decades have been towards an increasing importance in raw material imports on the one hand and a decrease in the percentage of the imports coming from the United States on the other.

Softwood lumber is the major wood import, comprising 50 percent of the total volume, but has been slowly declining in importance relative to other wood imports.

About 80 percent of the hardwood lumber imported is mahogany from Mexico and the United States.

Imports of railroad crossties have shown a definite decline in volume since 1940 to less than one million bd. ft. Most of the ties imported are of southern yellow pine.

From a negligible volume in 1940, plywood imports have jumped to more than 30 million sq. ft. annually. About half is Douglas-fir; foreign plywood shipments are mainly baboen from Surinam and lauan from Japan.

Furniture and millwork imports have remained more or less constant in relative importance. The local industry supplies most of the medium and lower priced articles.

Minor products such as utility poles, wooden containers, and cooperage have also remained more or less constant in relative importance.

Pulp and paper imports make up about half of the total wood and paper imports in value; containers and bags represent about one-third of total paper in value terms.

RESUMEN

La madera y el papel representan como el 5% de los artículos importados en Puerto Rico. En el 1960 su valor ascendió a $46 millones de cuyo total Estados Unidos suministró 72%.

Durante las últimas dos décadas la importación de madera y papel, por una parte giró hacia una creciente importancia en la importación de materia prima y por otra parte en una disminución en el porcentaje suministrado por los Estados Unidos.

Las maderas coníferas representan la mayor parte de la importación, cubriendo como 50% del volumen total, pero poco a poco su importancia ha venido disminuyendo en comparación con otras maderas.

La caoba representa el 80% de las maderas angiospérmicas, importada de México y los Estados Unidos.

Desde el 1940 la importación de traviesas ha disminuído definitivamente en volumen, a menos de un millón de pies tablares. Casi todas las traviesas provienen del pino amarillo del sur de los Estados Unidos.

1/ Prepared as a special report for the 1962 Syracuse Forestry Summer Course, conducted by New York State University College of Forestry at Syracuse, in cooperation with the U. S. Forest Service Institute of Tropical Forestry.

De un volumen insignificante en 1940 las importaciones de tableros contrachapados han ascendido a más de 30 millones de pies cuadrados anualmente. Como la mitad provienen del "Douglas-fir"; los cargamentos extranjeros provienen mayormente del baboen en Surinam y del lauan en Japón.

Los muebles y maderas industriales han permanecido más o menos en el mismo nivel de importancia relativa. La industria local suministra casi todos los artículos de precios medianos y más bajos.

Tales productos menores como postes, cajas y barriles también se han mantenido más o menos constantes en importancia relativa.

La pulpa de madera y el papel abarcan casi la mitad del total del valor de las importaciones de madera y papel; los envases y bolsas representan como una tercera parte del total del papel en términos de valor.

Wood and paper imports make up about 5 percent of the total value of all commodity imports into Puerto Rico, or $46 million in 1960, about evenly divided between wood products and paper products, see Table 1.

Table 1.—*Value of wood and paper imports into Puerto Rico, selected years in current U.S. dollars.*

Year	Wood and Paper		Total		Sawmill Products			Plywood and Veneer	Furniture and Millwork	Minor Products
	Per Cap	Total	Paper	Wood	Softwood	Hardwood	Crossties			
	dollars	thousand dollars								
1935	2.1	3,622	1,426	2,195	1,089	31	140	---	585	351
1938	2.8	5,003	1,810	3,193	1,546	76	93	---	995	484
1940	3.3	6,113	2,210	3,903	2,179	119	105	---	949	551
1941	3.2	6,093	1,789	4,305	2,744	127	77	7	788	568
1942	5.2	9,991	4,115	5,879	3,080	149	150	27	1,585	889
1943	1.5	3,003	2,075	928	425	139	77	---	128	160
1944	4.2	8,537	5,084	3,453	1,605	676	140	36	429	567
1945	3.9	8,030	3,872	4,158	2,027	883	119	65	686	378
1946	7.1	14,741	4,956	9,785	6,185	1,168	147	91	1,319	875
1947	8.1	17,110	6,570	10,540	6,488	361	274	392	1,723	1,301
1948	9.6	20,604	8,328	12,275	8,231	416	156	351	1,932	1,190
1949	8.0	17,504	7,609	9,895	6,205	398	204	447	1,655	986
1950	7.5	16,631	7,245	9,386	5,702	425	119	319	2,010	811
1951	10.2	22,846	10,666	12,180	7,581	514	139	683	2,026	1,237
1952	11.1	24,765	13,020	11,745	6,889	630	130	715	2,203	1,178
1953	12.0	26,318	11,748	14,570	8,348	1,129	46	666	2,481	1,900
1954	11.6	25,568	11,975	13,593	7,189	1,507	104	1,038	2,186	1,569
1955	12.5	28,065	13,393	14,671	8,494	1,095	113	1,454	1,920	1,595
1956	14.5	32,546	16,308	16,238	8,723	1,429	179	1,563	2,297	2,047
1957	16.3	36,728	18,654	18,075	9,355	1,827	83	1,563	3,479	1,768
1958	15.9	36,904	19,502	17,402	8,322	1,228	73	1,760	3,853	2,167
1959	16 6	38,373	20,842	17,531	8,081	1,553	82	2,089	3,386	2,341
1960	19.7	46,227	23,110	23,117	10,956	1,637	35	3,098	4,301	3.089

Source: Annual Book of Statistics of Puerto Rico, 1935-1950; Dept. of Agriculture and Commerce. External trade statistics. Statistical Yearbook, 1951-1960; Puerto Rico Planning Board.

Trends over the last two decades fall into two categories. First is the change in the nature of the imports. Raw materials used by the local wood working industries are rapidly increasing in importance, while general utility wood and paper products are decreasing in relative importance. Second, the percentage of the total wood and paper

imports which come from the United States has dropped, from 96 percent of all imports in 1940 to 72 percent in 1960. Wood and paper imports in 1960 came from 40 different countries, including 15 in Latin America.

WOOD IMPORTS

In a survey made in 1954, Longwood[2] estimated that less than 2 percent of the wood used by Puerto Rican industries, and probably less than 1 percent of all primary forest products, came from local timber supplies. The figure is probably even smaller today. Puerto Rico, is, therefore, almost entirely dependent on imports to supply her industrial wood needs.

In 1960, the United States supplied 53 percent of the total wood import, Canada contributed 26 percent, and Latin American countries about 18 percent. Even though Puerto Rico is far behind the more advanced industrial countries in wood consumption, the island's per capita consumption is surprisingly high for a country dependent on external sources of supply. In 1960. consumption of sawmill products for selected countries was as follow:

Country	Bd. ft./capita[3]
United States	212
Europe	70
Trinidad and Tobago	59
PUERTO RICO	54
South America	27
Jamaica	15
Cuba	13
Mexico	11

Softwood lumber is the major wood import, about 50 percent of the total; however, softwood imports have been declining in importance since World War II. Hardwood imports have, on the other hand, been steadily increasing in importance. Manufactured wood products, such as furniture and millwork, have remainded more or less constant in relative importance over the years. The changes in relative importance of the various major wood products imported into Puerto Rico since 1940 are shown in figure 1.

SAWMILL PRODUCTS

Most Puerto Rican homes are constructed of non-wood materials, such as cement. The major uses of construction lumber are for scaffolding and forms. Softwood lumber imports, while declining in relative importance, have nevertheless shown a 40 percent increase in volume over 1940 imports, to a total volume of 11,550 thousand bd. ft. in 1960, see Table 2.

In 1958, Canada replaced the United States as the major supplier of softwood lumber to Puerto Rico. In 1950, the United States supplied 85 percent of the softwood, Canada 7 percent. In 1960, Canada supplied 58 percent, the United States 23 percent. Imports from Canada are primarily true firs (*Abies* spp.), Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco), hemlock (*Tsuga* spp.), and spruce(*Picea* spp.). The imports from the United States are mainly southern yellow pine *(Pinus elliottii* Englm., *P. echinata* Mill., *P. palustris* Mill., and *P. taeda* L.) and Douglas-fir. Other important softwood imports are Caribbean pine (*Pinus caribaea* Mor.) from the Caribbean mainland, and Paraná pine (*Araucaria angustifolia* (Bertol.) O. Kuntze) from Brazil.

The furniture and millwork industries are the major users of hardwood lumber in Puerto Rico. The rapid increase in hardwood imports shown in Figure 1 reflects the increased capacity of these two industries: 57 plants with 919 employees in 1939; 233 plants with 3454 employees in 1960[4]. Bigleaf

2/ Longwood, F. R., "Industrial wood use in Puerto Rico," Caribbean Forester 16:3:94. 1955.
3/ Food and Agricultural Organization, Yearbook of Forest Products Statistics, 1961, United Nations, Rome, pp. 120-121.
4/ Department of Labor, Division of Statistics, Commonwealth of Puerto Rico.

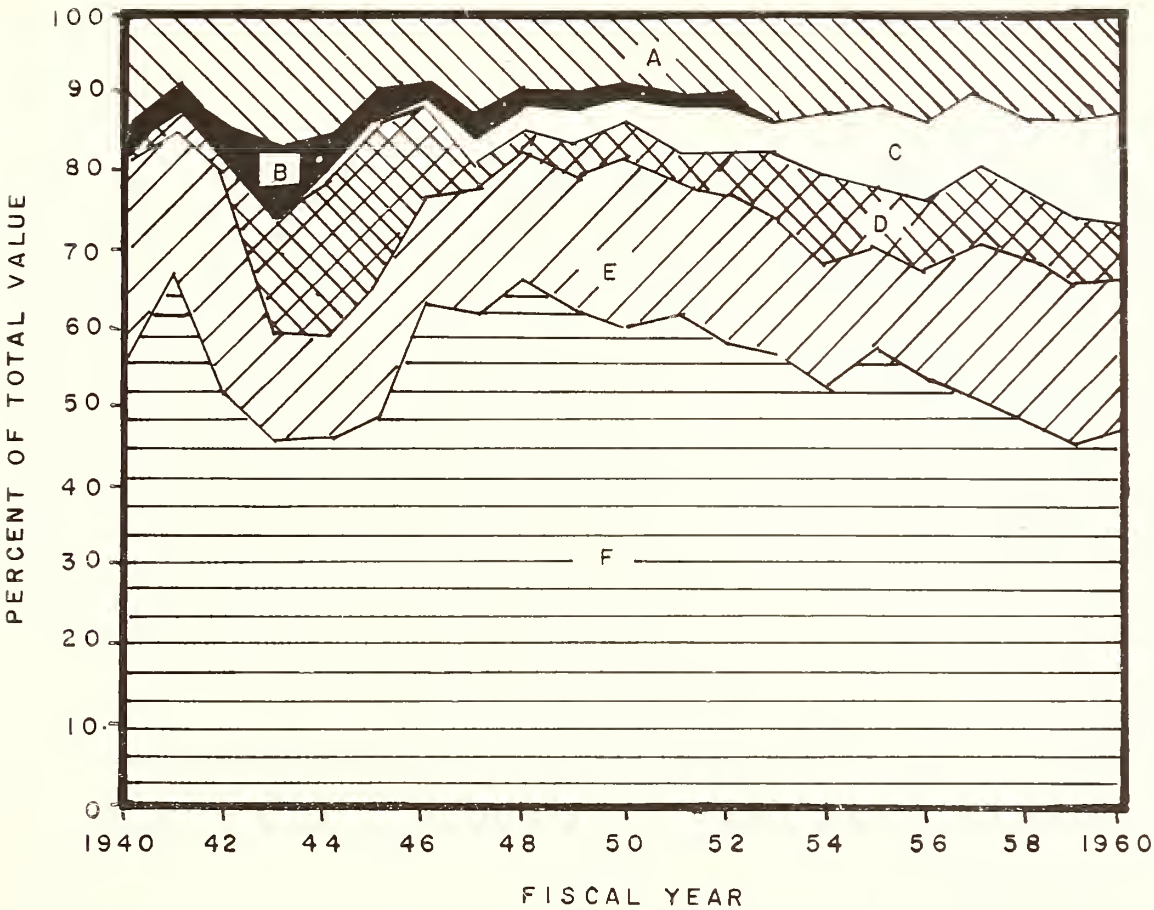

Figure 1. Major wood imports into Puerto Rico, 1940-1960.
A. Minor wood products C. Plywood and veneer E. Furniture and millwork
B. Railroad crossties D. Hardwood lumber F. Softwood lumber
Source: Annual book of statistics of Puerto Rico, 1940-1950; P. R. Dept. of Agriculture and Commerce. External trade statistics, Statistical Yearbook, 1951-1960; P. R. Planning Board.

mahogany (*Swietenia macrophylla* King) makes up approximately 80 percent of all hardwood lumber imports. Most of the mahogany comes from Mexico or the United States. The latter shipments are re-exports from Central and South America. Spanish-cedar (*Cedrela mexicana* Roem) and balsa (*Ochroma lagopus* Sw.) make up the bulk of the remaining hardwood imports. American hardwoods imports, such as birch (*Betula* spp.) and oak (*Quercus* spp), are negligible, about 160 thousand bd. ft. in 1960.

Railroad crossties were used by the two public railroads and the sugar companies. In recent years the railroad companies have discontinued operations and sugar companies have largely converted to rubber-tired wagons and trucks. For these reasons, tie imports have steadily declined to less than 1 million bd. ft. annually, Table 2. About 80 percent of this volume is southern yellow pine, mostly untreated.

PLYWOOD AND VENEER

Prior to 1940, no significant amount of plywood or veneer was being imported into Puerto Rico. Since then, annual imports have

Table 2.—*Volume of sawmill products imported into Puerto Rico, selected years.*

Year	Per Capita	Total	Import from U. S.	Import from Foreign	Softwood Lumber	Hardwood Lumber	Railroad Crossties
	Bd. Ft.	Thousand Bd. Ft.					
1935	34.1	58,744	55,489	3,255	50,507	428	7,809
1940	48.1	89,823	87,580	2,243	84,470	1,400	3,953
1950	36.6	80,951	69,296	11,655	76,443	2,693	1,815
1951	38.3	85,430	72,473	12,957	80,306	3,484	1,640
1952	35.1	77,911	70,748	7,163	71,970	4,749	1,372
1953	45.1	99,149	71,586	27,563	92,839	5,778	532
1954	45.6	100,909	64,812	36,097	92,669	7,071	1,169
1955	46.5	104,180	53,055	51,125	96,916	5,966	1,298
1956	45.8	102,638	53,369	49,269	93,488	7,630	1,520
1957	50.0	112,766	59,587	53,179	103,648	8,445	673
1958	48.0	109,703	36,120	73,583	101,627	7,360	716
1959	46.6	107,413	27,128	80,285	97,433	9,058	922
1960	54.1	127,047	30,724	96,323	177,550	9,043	454

Source Annual Book of Statistics of Puerto Rico, 1935-1950; Dept. of Agriculture and Commerce. External trade statistics, Statistical Yearbook, 1951-1960; Puerto Rico Planning Board.

Table 3.—*Volume of plywood and veneer imports into Puerto Rico, selected years.*

Year	Per Capita	Total	Imports from U. S.	Imports from Foreign	Plywood	Veneer
	sq. ft.	thousand square feet				
1945	0.4	873	873	---	863	10
1950	1.2	2,556	1,886	669	2,556	--
1951	2.1	4,775	2,917	1,858	4,763	12
1952	2.3	5,010	2,763	2,247	5,010	--
1953	2.8	6,075	3,098	2,977	6,075	--
1954	4.7	10,555	7,286	3,269	10,493	62
1955	6.4	14,529	8,655	5,514	14,467	61
1956	7.4	16,620	9,767	6,852	16,554	65
1957	7.4	16,554	10,328	6,226	16,503	51
1958	8.4	19,364	12,453	6,910	19,282	82
1959	8 8	20,251	10,379	9,872	20,232	19
1960	13.1	30,849	16,856	13,993	30,847	2

Source: Annual Book of Statistics of Puerto Rico, 1935-1950; Dept. of Agriculture and Commerce. External trade statistics, Statistical Yearbook, 1951-1960; Puerto Rico Planning Board.

steadily increased, Table 3, to over 30 million sq. ft. valued at $3 million. Veneer imports are of minor importance.

About half of the plywood imported is from softwoods, primarily Douglas-fir from the western United States, for use in construction work. Imports from foreign sources are mainly mahogany or wood closely resembling it in texture and color, but cheaper in price. About half of the foreign plywood is baboen (*Virola surinamensis* (Rol.) Warb.) from Surinam. Imports from Japan have increased considerably in the last 5 years, to 37 percent of all plywood imported in 1960. Puerto Rico also imports sizeable quantities of okoumé *(Aucoumea klaineana* Pierre) from Spain.

Masonite and particle board imports have increased substantially in the last few years. These materials are gaining popularity for use where they will be either hidden or painted over. Most processed board comes from the United States.

FURNITURE AND MILLWORK

Furniture imports have increased in value from less than $1 million in 1940, to almost $4 million in 1960. The United States supplied 98 percent in 1960. Most of the furniture is of the higher grade stock sold in the decorator-type stores[5]. The more economical grades are manufactured locally.

Millwork imports consist primarily of flush doors. In spite of an ever-expanding local millwork industry, millwork imports have more than doubled in the past 10 years to over half a million dollars annually. Almost all millwork imports come from the United States.

MINOR WOOD PRODUCTS

Minor wood products, as used here, includes those products characterized by a derived demand. That is to say, they are consumed as inputs by a non-primary industry. The consumption of these products may be expected therefore, to follow very closely the business trends of the consuming industry.

Utility pole imports have steadily increased to meet the needs of Puerto Rico's expanding power and communications system. In 1960, Puerto Rico imported 29,731 utility poles as compared to less than 2,000 in 1940. Besides utility poles, a limited volume of southern yellow pine and greenheart (*Ocotea rodiaei* (Schomb.) Mez) is imported for use as piling (88,215 lin. ft. of southern yellow pine and 24,816 lin. ft. of greenheart in 1960).

Wooden containers are used on the island by the fruit and vegetable industry and the soft-drink industry. Container imports have expanded from less than $200 thousand in 1950, to over $570 thousand in 1960. Cooperage imports, except for a post-war surge have only recently shown any significant increase in volume. Since 1957 imports have more than doubled to over $100 thousand in 1960. Container and cooperage imports come almost entirely from the United States.

Miscellaneous items imported are: pallets, wooden handles, shoe lasts, battery separators, etc. Most of these items are made from woods having special properties required by the user. Imports of these products tend to be small in volume and high in value.

PULP AND PAPER PRODUCTS

In 1960, pulp and paper imports into Puerto Rico came to $23 million, a ten-fold increase over 1940 imports. More than 90 percent of this import comes from the United States. Canada is the second largest supplier, with 6 percent.

Puerto Rico imports only a small volume of paper base stock. This stock is long fibered material used to strengthen the local short-fibered bagasse pulp. Approximately 1 400 thousand pounds of spruce pulpwood listed

5/ Wallace, Don. 1956. Possibilities for expansion of the Puerto Rican furniture industry. Unpublished report to the Economic Development Administration, Puerto Rico. 7 pp.

under this category is for use in the manufacture of insuldyne (a locally manufactured building material made from exselsior and cement).

In terms of both value and volume paper bags and paper containers have remained the major paper products imported into Puerto Rico. The 1960 value of $7 million, compared to $2 million in 1950 was 18 percent paper containers and 12 percent paper bags.

Other paper imports have also shown substantial increases in the last 10-20 years, but there have been shifts in the relative importance of the various products. In relation to total paper imports, coarse papers have declined from 18 percent of total value in 1950, to 9 percent in 1960. Imports of paperboard, wallboard, building board, etc. have also shown a slight decline in relative importance, from 10 percent in 1950 to 8 percent in 1960. Imports of fine papers have remained constant in relative value, at about 9 percent.

Although newsprint is the second major paper import in terms of volume (25,661,551 lbs. in 1960), in value it accounted for only 6 percent of total paper imports. This is a decline in relative importance from 10 percent in 1950.

Effects of Irrigating Tree Seedlings with a Nutrient Solution[1]

by

R. P. BELANGER AND C. B. BRISCOE

SUMMARY

Subsurface irrigation with nutrient solution was found to be biologically feasible under the conditions tested. Growth of seedlings was satisfactory, but not unusually good.

On the bases of total height growth and growth in fresh weight, the various fertilizers tested produced statistically different results.

The species tested, members of three different families and native to three different continents, reacted similarly to the nutrient solutions tested.

The highest root-to-shoot ratio obtained was in plain tap water.

RESUMEN

Se encontró que bajo las condiciones ensayadas el riego subterráneo con una solución nutriente es biológicamente factible. El crecimiento de las plantitas fué satisfactorio, pero no excepcionalmente bueno.

Basándose en la altura y el peso fresco, los distintos fertilizantes probados produjeron diferentes resultados.

Las especies usadas, miembros de tres diferentes familias y naturales de tres continentes distintos, reaccionaron de manera similar a las soluciones nutrientes ensayadas. Resultó mejor la proporción 7-6-19.

La relación más alta entre la raíz y el tallo se obtuvo usando agua corriente.

Fertilization in the nursery has long been an accepted practice for improving the vigor of tree seedlings (Hansen, 1923; Wilde *et al*., 1940; Vlamis *et al*., 1957).

Presumably there is an optimum combination of nutrients, possibly a different optimum for each species. In soil, however, the search for an optimum is complicated by the fluctuation of nutrient levels with time and by the varied interaction of soils with applied fertilizers.

One apparent means of minimizing these complications is growing seedlings in an essentially sterile medium and supplying nutrients in a frequently-replenished water solution. To eliminate possible toxic effects of fertilizer solution on the foliage and simultaneously avoid possibilities of oxygen deficiency in the root zone, subsurface irrigation appears more promising than surface flooding or sprinkling, or than water culture.

A study was undertaken (a) to test the feasibility of subsurface irrigation with nutrient solutions, (b) to determine the relative effects of several readily-available commercial fertilizers, and (c) to determine whether effects varied with species.

PROCEDURE

Forty-four vigorous seedlings approximately 2 weeks old of *Afrormosia elata* Harms from Nigeria, *Eucalyptus alba* Reinw. from Australia via Brazil, and *Cedrela mexicana* Roem. from Mexico were transplanted to perforated 5 x 9½-inch polyethylene bags filled with firmly packed vermiculite. Firm

1/ Begun as a special report for the 1962 Syracuse Forestry Summer Course, conducted by New York State University College of Forestry at Syracuse, in cooperation with the U. S. Forest Service Institute of Tropical Forestry.

cotyledons still remaining on the *Afrormosia* seedlings were clipped off at the time of transplanting. During the initial 6 days after transplanting seedlings were kept under a light shade and irrigated daily with plain tap water. Treatment started August 2, 1962.

TREATMENTS

Each species was irrigated with three different solutions of liquid fertilizer, plus a control of plain tap water. The fertilizers and their composition are listed in Table 1.

Table 1.—*Fertilizers and their composition*[1]

Fertilizer	Grams per gallon Nitrogen	Phosphorus	Potassium	Total
Water	0	0	0	0
18-18-18[2]	1.57	1.57	1.57	4.71
15-5-5	1.76	0.59	0.59	2.94
7-6-19	0.49	0.46	1.46	2.41

1/ Proprietary preparations the sources of which are available upon request.

2/ Numbers refer to percentages of nitrogen, phosphorous, and potassium, respectively.

Twenty gallons of each fertilizer solution and the control treatment were prepared initially and replenished periodically.

Each solution was applied to 11 seedlings of each species every day for 60 days and twice weekly thereafter. The seedlings were placed in a perforated polyethelene pail which was immersed slowly into the fertilizer solution to a level assuring complete saturation of the vermiculite without wetting the stems. When the vermiculite was saturated the pail was lifted out of the solution and allowed to drain. The three solutions using the commercial fertilizers were stirred thoroughly each day before irrigation, to disperse a precipitate which formed in the bottom of the container. A plastic and meshwire screen was kept over the plants to reduce solar radiation and prevent leaching of the nutrients by heavy rains. The groups were re-positioned daily to minimize the effect of variations in the microenvironment.

MEASUREMENTS

The height of each plant was measured to the nearest millimeter, after immersion, every fourth day for the first 60 days and weekly thereafter. Each plant was measured from a marked spot on the surface of the vermiculite to the apex of the terminal leader, not including leaves or leaflets.

Immediately after the final measurement at 85 days, each plant was lifted from the pot, cut in two at the ground line, and each part weighed. Oven dry weights were determined for each group. That is, roots of all plants of each species and of each fertilizer were weighed together, not individually.

RESULTS

Cumulative height growth is shown in Figure 1. Although the magnitude of the growth differed greatly, the rank of the fertilizer solutions was the same for all three species. Height growth varied significantly with species and with nutrient solution.

Fresh weights are shown in Table 2. On

Table 2.—*Fresh weights after 85 days*

Treatment	Species Afrormosia	Cedrela	Eucalyptus	Mean
	Shoot Weights, Grams			
Water	1.2	1.4	7.2	3.3
18-18-18	1.0	2.6	8.5	4.0
15-5-5	1.0	1.4	3 2	1 9
7-6-19	2.7	7.7	14.4	8.3
Mean	1.5	3.3	8.3	
	Root Weights, Grams			
Water	0.9	0.8	5 7	2.5
18-18-18	0.7	1.4	5.6	2.6
15 5-5	0.7	0.6	1.5	0 9
7-6-19	1.6	3 3	7.1	4 0
Mean	1.0	1.5	5 0	

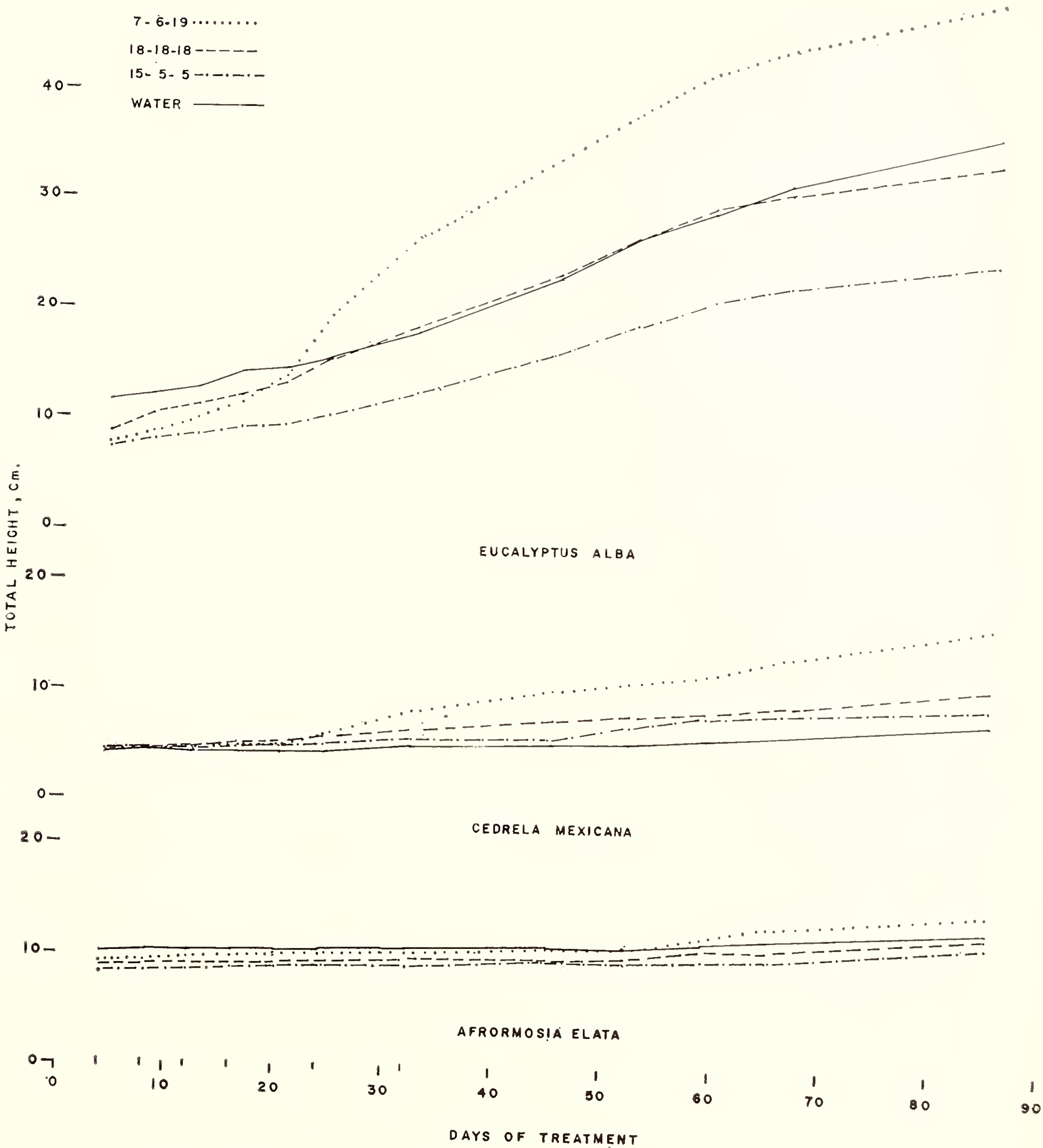

Figure 1. Height growth with subsurface nutrient irrigation.
Crecimiento en altura con riego subterráneo de solución nutriente.

the basis of fresh shoot weight, the three species differed significantly from each other, as did the four treatments.

On the basis of fresh root weight *Eucalyptus* is significantly heavier than the other two species, which are not different from each other. Treatment 15-5-5 is significantly poorer than water and 18-18-18, which in turn are inferior to 7-6-19.

On the basis of root-to-shoot ratio, Table 3, the species did not differ significantly from each other. The plants treated with fertilizer solution did not differ from each other, but, treatment with 15-5-5 and 7-6-19 gave results which differed highly significantly from the Controls.

Table 3.—*Root-to-shoot ratio after 85 days, fresh weight.*

Treatment	Species			Mean
	Afrormosia	Cedrela	Eucalyptus	
Water	0.8	0.6	1.0	0.8
18-18-18	0.7	0.6	0.7	0.7
15-5-5	0.7	0.5	0.5	0.6
7-6-19	0.6	0.4	0.5	0.5
Mean	0.7	0.5	0.7	

The trends in dry weights followed those for fresh weight. However, as noted above individual seedling roots and stems were not weighed dry and differences based only on total dry weights were not statistically significant.

Some visual differences were noted.

Cedrela mexicana produced excellent leaf growth and vigor in solutions 18-18-18 and 7-6-19.

Height and leaf growth of *Eucalyptus alba* were exceptional under treatment 7-6-19. Treatment 18-18-18 produced a reddening of the meristematic regions and a profuse growth of branches. Treatment 15-5-5 produced much less growth and resulted in leaf burn and curling of the tips of the upper leaves.

Afrormosia elata growth consisted primarily of the development of leaves with very little stem growth. In addition the *Afrormosia* seedlings suffered somewhat from what appeared to be sun scald.

DISCUSSION

The three objectives of the study were fulfilled, but the results were somewhat unexpected.

Although the results of Vlamis *et al.* (1957) suggest high nitrogen and phosphorous levels promote rapid growth such was not the result in this study.

Relatively high potassium is expected to stimulate meristematic development (Meyer and Anderson, 1939), but shoot growth was stimulated more by potassium than root growth. The greatest ratio of roots-to-shoot, on a fresh weight basis, was obtained by irrigating with plain tap water.

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Preservation of Puerto Rican Fence Posts Treated By Pressure Methods[1]

by

VICTOR R. ORTIZ

SUMMARY

Posts of five species were treated by three standard pressure methods, except that cold preservative was used. Results of non-pressure treatments previously applied to the same species are also included.

Assuming 6 pounds per cubic foot is satisfactory retention, the hot-and-cold bath and full cell treatments ar satisfactory, as is the Lowry treatment except for **Myrcia coriacea**; the cold bath and the Rueping (with cold preservative) were inadequate.

RESUMEN

Se trataron postes de cinco especies usando tres métodos a presión standard con la excepción de que se usó preservativo frío. También se incluyen los resultados de tratamientos sin presión previamente aplicados a las mismas especies.

Asumiendo que la retención de 6 lbs. por pie cúbico es satisfactoria, el baño caliente-frío y el tratamiento de célula completa son satisfactorios, como lo es el tratamiento Lowry, excepto con la especie **Myrcia coriacea**; el baño frío y el tratamiento Rueping (con preservativo frío) no resultaron adecuados.

La penetiación resultó en correlación con la retención.

The forests of Puerto Rico contain numerous species of trees that grow only to fence post and pole size. The removal of these trees would probably increase the growth of the remaining and more desirable trees. Most of the trees in Puerto Rico which yield naturally durable fence posts have been cut, and the non-durable species last only six months to two years in use. Even for species that may have durable heartwood, post-size trees often are mostly sapwood not resistant to decay or insect attack.

It has been proved that the treatment of non-durable fence posts with a good oil-borne preservative at a retention of six pounds per cubic foot and accompanied by good penetration will increase the service life of the posts several fold (1). This paper presents a summary of information on the treatment of five species.

1/ Prepared as a special report for the 1962 Syracuse Forestry Summer Course, conducted by New York State University College of Forestry at Syracuse, in cooperation with the U.S. Forest Service Institute of Tropical Forestry.

PREVIOUS WORK

Limited work has been done on preservative treatment of wood by pressure methods in Puerto Rico. In 1959 the Division of Forests of the Puerto Rico Department of Agriculture started a study with 15 species which did not include moisture content nor penetration results.

Limited tests on 31 species by cold soaking in 1952 yielded a retention of 3 to 15 pounds per cubic foot (2). An intensive study begun in 1958 by the U. S. Forest Service Institute of Tropical Forestry involved the treatment of 52 species by cold soaking with 5 percent pentachlorophenol in diesel oil, 21 species by the hot-and-cold bath method with 5 percent pentachlorophenol, and 10 species by both treating methods with a 50-50 creosote and diesel oil solution (3).

PROCEDURE

Five of the most common species used as fence posts in Puerto Rico were selected for the study. Seven-foot posts were air dried for 2-½ months and their moisture content was determined. The species and their moisture contents are listed below.

Common Name	Scientific Name	Moisture Content (percent)
Pino australiano	*Casuarina equisetifolia*	17
Pomarrosa	*Eugenia jambos*	29
Hoja menuda	*Myrcia coriacea*	30
Caimitillo	*Chrysophyllum bicolor*	27
Mantequero	*Rapanea ferruginea*	20

All species were treated by pressure methods with a 5 percent pentachlorophenol solution in diesel oil. For each method, 25 posts of each species were used. A brief description of each pressure method follows:

1. Rueping
   - a) Air pressure is applied to the wood in the treating cylinder.
   - b) Cylinder is filled with preservative, maintaining the air pressure.
   - c) Pressure is applied.
   - d) A vacuum is drawn on the treated wood.
2. Lowry
   - a) Preservative is admitted to the treating cylinder at atmospheric pressure.
   - b) Pressure is applied.
   - c) Final vacuum on the treated wood in the treating cylinder.

Full-Cell
   - a) A preliminary vacuum is applied to the wood in the treating cylinder.
   - b) Preservative is admitted into the treating cylinder, without admitting air.
   - c) Pressure is applied.
   - d) A final vacuum is applied.

In all the treatments except Rueping the pressure applied was 125 pounds per square inch for 30 minutes and the vacuum was of 27.8 inches of mercury for 30 minutes also. In the Rueping process, an initial air pressure of 50 pounds per square inch for 15 minutes was applied.

No heat was used with any pressure treatment.

Each post was identified and diameter measurements were taken at the top and base. Average diameter and volume were determined for each post for the purpose of expressing the retention of preservative by cubic foot. Retention of preservative per post was determined by weight before and after treatment. Table 1 shows the average retention of preservative. None of the species absorbed more than 4.5 pounds of preservative by the Rueping method; while all of them except *Myrcia* retained more than six pounds by the other two methods. Probably these low retentions in *Myrcia* are due to its high moisture content and high density. The posts treated by cold soaking and hot-and-cold-bath were air dried to a moisture content of 16 to 20 percent. The data for these methods is included to permit comparison with the pressure methods.

Table 1 also shows penetration obtained. From each batch of 25 posts, the 5 with retention nearest the mean were selected for penetration measurements, which were made at intervals of one foot.

The lowest penetration was obtained with *Myrcia* and the highest with *Casuarina*. It appears that the higher the retention per cubic foot the higher the penetration of the preservative. With the hot-and-cold bath the penetration of the preservative is very good. Probably penetration would be higher in some species if they were dried to a lower moisture content.

Table 1.—*Summary of treatment results*

Species	Rueping	Lowry	Full-ceil	Cold-bath	Hot-Cold Bath
	Retention, pounds per cubic foot				
Casuarina equisetifolia	4.20	6.99	9.98	5.5	78
Rapanea ferruginea	3.97	6.89	9.36	6.3	–
Chrysophyllum bicolor	3.21	6.71	8.48	5.7	8.2
Myrcia coriacea	1.40	2.59	2.86	2.7	7.1
Eugenia jambos	3.34	6.53	6.83	4.9	10.6
Mean	3.22	5.94	7.50	5.0	8.4
	Penetration, percent of the radius				
Casuarina equisetifolia	100	100	100	70	100
Rapanea ferruginea	40	45	100	50	–
Chrysophyllum bicolor	18	30	40	45	60
Myrcia coriacea	10	16	22	12	100
Eugenia jambos	21	78	100	22	60
Mean	38	54	72	40	80

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E R R A T A

The third paragraph on the left hand column of page 57 should be:

"An additional advantage of the Holdridge system is that it has been rather widely applied in the American tropics (Holdridge 1962, 1957; Holdridge & Budowski 1956; Holdridge & Hunter 1961; Holdridge, Lamb & Mason 1950; Tosi 1960; Veillon 1963; Tropical Forest Research Center 1960). Thus a large body of information concerning counterpart areas is readily available if the same system is applied locally."

The second paragraph under PROCEDURE on page 57 should be:

"The Weather Bureau Climatological Data, Puerto Rico and Virgin Islands (1898-1934, 1935-1954, 1961) yielded 26 stations for which the annual means and deviations from the long term means were listed. The long-term means of these stations were calculated by algebraically substracting the deviation from the annual mean."

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(Corrected, pp. 64-65)

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